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Forthcoming Event.

AUGUST 3, 4, AND 5.

British Foundrymen's Association.—Annual National Convention at Birmingham.

NOTES AND COMMENTS.

Electric Furnaces.

On another page we give an abstract of a paper on "The Electric Furnace," read before the Iron and Steel Institute recently by Herr W. Rodenhauser. The author makes some very interesting comparisons between furnaces of the arc type and the induction type, but, as will be seen from the discussion which followed the reading of the paper, his conclusions did not meet with universal acceptance. It should be noted that Herr Rodenhauser writes from a decided "Röchling-Rodenhauser" standpoint, and it is fairly obvious that he is very much prepossessed in favour of his own furnace. The paper cannot, of course, be taken as a treatise on electric furnaces in general, nor does it pretend to be such; the references to, and criticisms of, other types may be taken more as an introduction to a consideration of the Röchling-Rodenhauser furnace, which, it must be admitted, stands as, at least, one of the best that have been evolved. With every furnace that has attained a position of commercial importance, such as the Stassano, the Héroult, the Girod, the Kjellin, and the Frick, there are associated some special features which recommend them individually for certain work, and to those who favour any of these furnaces the brief dismissal as possessing disqualifying features, which Herr Rodenhauser accords to all furnaces save his own, may appear rather arbitrary. If, however, his remarks stimulate investigators to a detailed comparison of these different furnaces, as regards efficiency and economy, they will have served a good end.

The Moulding Machine and Shop Prejudice.

One becomes so accustomed to regarding the moulding machine as an essential adjunct to the modern foundry that the troubled tone of one pessimistic foundry engineer writing in the "Iron Age" comes somewhat as a shock.

"The struggle of the moulding machine," says the writer, "has been one almost without an equal. No uniform results have been obtained from its use in Union foundries, the day's work always being agreed upon between the workmen and the machine operator. Boys have been tried as operators on a premium system, but only to be weeded out after a short time. A few good days' work would be done and then something would go wrong, or the machine would break. Not only does this prejudice exist in organised shops but in partial Union shops. The better way in introducing the machine is to contract with the company selling the machine to furnish an operator to start the machine and turn out a certain production on a given casting with a stipulated loss. The influence of the moulders' prejudice will be more keenly felt when the company undertakes to place machines in the shop than at any other time. Many men feel that the machine is a direct menace to

them and do all possible to prevent its successful operation. However, the machine, both automatic and semi-automatic, is fast coming into use, and these prejudices might as well be dropped." The writer then proceeds to suggest that the best solution is for various shops to combine and let out certain work to be made on machines, a number of concerns to own a plant for this, which would have nothing but machine equipment, with no one allowed to work in the place except machine operators on a piece-work basis.

This, it is claimed, would make a speciality of machine moulding, and the whole situation would then change and many shops would want the machine in their possession in order to "keep their men in a job." The machine, it is further claimed by this writer, will never be a success unless some step of this kind is taken for its protection and future welfare.

We make no attempt to deny the prejudice which has been faced by the moulding machine since its introduction, and is in many quarters still being faced. But we cannot commend the tone adopted by the foundry engineer, whose opinion we have quoted. He claims that the moulding machine is essential, but because he has encountered strong prejudice against it on the part of the operators he capitulates to their demands, and proceeds to suggest, not a straight way of educating the men out of their prejudice, but a more or less doubtful and impracticable method of circumventing the men and forcing them to acquiesce to the installation of the machines. We venture to think that the average British founder, at any rate, would not consider such a proposition, but would rather take the question in hand squarely, and prove to his men that the moulding machine can be made as much their benefactor as his. It is a recurrence of the old fight against machinery that has been waged by the worker in all ages; but to-day we have valuable precedent for adopting more advanced methods, and it should surely not be necessary to cave in before the prejudices of a more or less small section of the trade and adopt roundabout methods to gain an end which it is generally acknowledged is steadily becoming accomplished.

Titanium Alloy in Car Wheels.

The use of titanium alloy in chilled iron car wheels was recommended in a paper recently read before the Railway Club of Pittsburg, by Mr. C. V. Slocum. He stated that the addition of 1 per cent. of titanium alloy has the effect of making the metal closer grained, and free from blow-holes, and thus the wheels are stronger in the flanges, rims, plates, etc. The chemical change includes a reduction in combined carbon of about 0.50 per cent. and an increase of the graphitic carbon of the same amount. This change reduces the chill somewhat, but improves the metal's wearing qualities. The use of this alloy in car wheels increases the cost from 3s. to 4s. per wheel, including the manufacturers' labour and profit. It has also been found that ingot moulds containing less than 1 per cent. of titanium alloy, when in use after dusk, can be picked out immediately from other moulds. Those not containing the titanium alloy become red hot from the molten steel, while the treated moulds remain almost black. An iron containing titanium alloy has a low percentage of heat absorption, and consequently there is less expansion and contraction.

Manganese, Calcium and Aluminium as Deoxidisers.

The relative deoxidising properties of magnesium, calcium and aluminium have often been the subject of discussion. Messrs. F. E. Watson and H. R. Ellis (Faraday Society, December 15, 1908), have determined that aluminium oxide is reduced by magnesium and by calcium, and that calcium oxide is reduced by magnesium. They draw the conclusion that the heat of combustion of magnesium is slightly greater than that of calcium, and that it is greater in the case of calcium than in aluminium. The results, therefore, show that magnesium is a stronger deoxidising agent than either calcium or aluminium, and that calcium is stronger than aluminium. The claim that aluminium is benefited by the addition of a small amount of magnesium is thus probably accounted for, as it is likely that the magnesium reduces the oxide of aluminium in the molten aluminium.

A Westralian Foundry.

Those who appreciate the important part which the foundry plays in industrial life will not be surprised to learn that there is in existence a foundry of considerable dimensions in Kalgoorlie, which is the centre of mining in Western Australia. At Messrs. Silverthorne & Adair's works there are appliances and men ready to undertake and execute any reasonable order which mechanical engineers may require. The works include spacious machine and fitting shops, casting floor and furnaces, and pattern shop, covering an area of four acres. A striking feature of the machine shop is a powerful steam hammer, while a lathe installed is capable of turning any work up to 15 ft. in diameter and weighing up to 10 tons, and recently turned the shaft of a winding engine, the forging from which it was turned weighing 8 tons. The furnaces are very completely equipped, and one of these is capable of treating 30 tons per day. There is an overhead hydraulic travelling crane, capable of lifting 20 tons, and used for boiler rivetting work, and this is claimed to be second to none in Western Australia. To facilitate the receipt of material for the works and the despatch of executed orders, there is a private siding from the Government railway line. The loading and unloading facilities include cranes capable of lifting 20 tons, and in addition there is a Marshall traction engine which is used exclusively for transport purposes from the foundry to the mines.

These works were established in 1898, and comprise what was the outfit of four separate foundries in operation at Kalgoorlie and Boulder. A steam saw mill is attached to the works, and is employed in shaping the timber for the pattern shop. The patterns are stored in a separate two-storey building, and it is stated that over 4,000 are accommodated there. The organisation and arrangement of the foundry is quite up-to-date, and the works give permanent employment to over 100 men.

B.F.A. Forthcoming Annual Convention.

At a meeting of the Birmingham Branch of the British Foundrymen's Association, it was announced that with regard to the fifth annual Convention, which will commence in Birmingham on Tuesday, August 3, the business meetings will be held in the old University buildings (originally Mason College), in Edmund Street. A visit will be paid on one afternoon during the week (probably Tuesday) to the new University buildings at Bournbrook, and the visiting members of the Convention will be entertained to tea by the members of the Birmingham Branch.

Mechanical Testing.

British Foundrymen's Association.—Birmingham Branch.

Lecture by Mr. F. J. Cook.

At a meeting of the Birmingham Branch of the British Foundrymen's Association, held at the Municipal Technical School, on Saturday, May 22, Mr. F. J. Cook (President of the National Association), gave a lecture on "Mechanical Testing in the Foundry." Mr. Robert Buchanan was in the chair, and there was a good attendance of members.

Mr. Cook said that until quite recently the methods generally adopted by foundrymen for testing the quality and physical properties of pig-iron consisted of noting the ease with which the pigs were broken when dropped on the breaker, the colour and openness of the grain shown by the fractured surface, the roughness of the surface, and the liability to sinking when the iron was used in castings. It had to be admitted that there had been foundrymen who had so trained their faculties of observation as to be able to produce by such methods work equal to anything now being made. How far they were assisted by blast furnace conditions it was difficult to say; but it was certain that when the ore used was that obtained locally, as it used to be, certain brands of pig-iron could be relied upon for definite characteristics which, owing to foreign and mixed ores being used, could not now be ensured. He was also inclined to think that when smelting the local ores, as was formerly the practice, with cold or semi-cold blast and with furnaces less rushed than at present, a much more regular product was obtained. Certainly, the irons then produced were not nearly so irregular as those produced now.

A partial analysis of pig-irons taken by Mr. Hailstone, of Birmingham, dealing with a number of consecutive deliveries from well-known South Staffordshire furnaces, showed that it was obviously out of the question to get uniform results at the present time by the old rule-of-thumb methods. From the old-fashioned method of testing, the pendulum swung to the opposite extreme, and then they had it asserted by chemists who had had no foundry experience that chemical analysis was the cure for all evils. But in due course it had been found that chemical analysis was only one of the methods to be employed for determining the quality and physical properties of pig-iron and iron castings. That chemical analysis alone would not ensure definite physical properties in castings could easily be proved. By those who were in the habit of making regular tests of cast iron it was frequently asserted that chemical analysis will not ensure definite physical properties, and that with irons of varying chemical composition similar high test results can be obtained. The examples he had quoted, and others which he would adduce, gave proof of this, and also of the fact that the ruling factor was not only the quantity of the element present, but also the condition of the element. It would also be seen that the rate of cooling had produced a most marked effect upon the structure of the casting. This was also as true in regard to pig-iron, the range of temperature through which the pigs had to cool having a large effect upon the grain, and therefore upon the physical properties of the metal. He was glad to be able to quote in confirmation of this view the opinion of an eminent blast-furnace manager, namely, Mr. Herbert Pilkington, who in his Presidential Address to the Sheffield Branch of the Association, said:—"Furnacemen have always been fully conversant with the fact that the varying temperature at which pig-iron leaves the tapping hole of the furnace has a powerful effect on its physical characteristics. The temperature of a large modern blast furnace is very much higher, and the metal therefore takes very much longer to cool than that which leaves the tapping hole of the smaller furnaces. Pig-iron from these extreme types could be made practically alike in chemical composition, but would behave physically in a different manner altogether, and would show very different grades, grains, and degrees of hardness."

Mr. Swinden, of Sheffield, told him (the lecturer) that in certain Swedish furnaces it was found that with an increased output iron of similar chemical analysis yielded physical properties altogether different, and the producers had to return to the old slower process. This question of the rate of cooling was also, he believed, the cause of different opinions as to how far chemical analysis could be relied upon as a guide to definite physical properties of castings. He had heard one person say that in 99 cases out of 100 he found chemical analysis a sure guide to work to; another had said that though he found chemical analysis very useful to him, he could not go anything like so far as the first statement; whilst a third stated that his results were frequently so different from what he had expected that he was unable to say that he found working to analysis very reliable.

In looking for a cause for this variance of opinion among men experienced in foundry work, he found that No. 1 was in the habit of making small and thin work, having quick and even cooling; the second dealt with medium-sized work, and the third had to deal with very heavy work with pieces of abnormally different thicknesses, and therefore with greatly varying rates of cooling. He believed that each was right to a large extent, the difference in rates of cooling being accountable for the varying experiences. With small and thin castings, such as stove grates, etc., where the rate of cooling was quick and uniform, the physical properties of the castings could be reliably governed by means of casting temperatures and chemical analysis only; but as the range of the work increased, and where, as was so often the case with engineering work, the articles were designed with abnormally different thicknesses, giving different rates of cooling in the same piece, other agencies must be brought into use besides analysis. It would be observed that he was not in any way trying to discredit chemical analysis, but simply wished to indicate how far it could be used alone as a guide for foundry working. His object was to point out some of the benefits to be derived from systematic physical tests in the foundry which could be made without the expenditure of much time or money.

Mr. Cook then recalled and illustrated some experiments which he has described on former occasions. One of the tests in question was that of shrinkage. The method of making the bars designed by Keep was very handy and cheap, he said, and it was surprising how well the work could be regulated when one had ascertained the contraction on the test bars, which coincided with the best results in the foundry. The machines in general use in this country for ascertain-

ing the transverse test of cast iron left much to be desired in regard to accurate working. In the cheaper ones the leverage could be effected by the operator, since it was necessary to move the poise along the beam by hand. There were other possibilities of error with this type of machine arising from the personal equation, and consequently the tests were far from satisfactory. All mechanical tests should be as far as possible purely mechanical, and leave a permanent record by means of charts or diagrams. There were now machines on which the poise was traversed by mechanism and which remained in position after the bar was broken, enabling the load to be checked. These, however, gave no deflection diagrams, and he much preferred the machine designed by W. J. Keep for use with the half-inch square bars made for shrinkage tests. This was free from the objections mentioned, the load being mechanically applied, the poise remaining stationary after the bar had fractured, and a deflection diagram also being obtainable.

When starting a system of tests for foundry comparisons, continued Mr. Cook, it was best to adopt one size of bar and always work to it; otherwise the comparisons would not be true. Iron bars did not follow, in regard to relative transverse strengths, the formula applied for strength of beams, owing to the skin area and rate of cooling having to be taken into consideration. But for forming a rough idea as to the strength of the various bars mentioned, Professor Turner gave it that a 1-in. by 1-in. bar tested on 12 in. centres had a breaking load equal to three-fourths of that obtained on a 2 in. by 1 in. on 3 ft. centres. After hundreds of tests, he (the lecturer) found that the breaking load on a ½-in. square bar by Keep's method was about one-sixth of that obtained by the 1-in. square bar on 12-in. centres. A very important point to watch with transverse tests was the deflection, as by it one got an idea of the flexibility of the metal, if one might use such an expression with regard to cast iron. Some people had an idea that to get a big deflection one had to get a soft iron, but the experiments of which he was giving them diagrams showed that they could not get a big deflection except with very strong iron. If they did not get a big breaking load, they did not get a big deflection. For testing hardness, which was, of course, of great importance with castings to be machined, and more especially where they were required for wearing parts of engines, there were now several forms of apparatus in vogue, all of such a character as to be readily used in the foundry. Brinell's method, that of forcing into the iron a metal ball of superior hardness and measuring the indentation, had been adopted by Messrs. Denison, of Leeds. The pressure was always the same, and the indentation was readily measured to one-thousandth of an inch by means of the special instruments provided. As the pressure and size of the ball were always constant, the indentation varied very directly with the difference in harness. Another type of instrument was that invented by Dr. Shore, of America, and called a "Scleroscope." This consisted of an arrangement for dropping a hammer on the specimen to be tested and measuring the distance the hammer rebounded. The drop hammer measured a quarter of an inch diameter by three-quarters long, and had a slightly convex point one two-thousandth five-hundredths of a square inch in area. It was dropped down a glass tube a distance of 10 in., being raised to the top and released by an india-rubber bulb, and there was no friction between the hammer and the tube. As no force other than gravity was used, the energy expended on the material was a fixed quantity, and the resultant rebound would be proportional to the varying resistance to penetration. A machine of this character in Birmingham had done very good work, but he had been told that the condition of the surface had a good deal to do with the extent of the rebound.

Another method was that of drilling. The only machine he knew of that was specially made for this form of test was Keep's, which provided an automatic record. An ordinary sensitive drilling machine, however, could be made quite easily to fulfil the requirements for this test by attaching a wheel to the feed spindle, from which a weight was suspended in such a manner as to give a direct downward pull on the drill. To the drill spindle was fixed a pencil which marked the diagram on squared paper attached to a drum revolving at a known rate. In fixing a standard for this test he preferred taking the number of revolutions to drill to a depth, as this, besides being more easily taken, conveyed a better appreciation of the difference in hardness than taking the angle of the chart. The test bars should be of uniform size or the results would be conflicting. This test was also a guide to the general strength of the iron, as hardness played an important part in this respect. Diagrams reporting the results of seventy consecutive tests with the same class of hard iron, showed that hardness had been an important factor in the transverse and tensile results obtained. With hard iron the highest transverse results were obtained with iron a little softer than that which gave the best tensile tests.

The question of blast pressure, generally speaking, received very little consideration from foundrymen, but where high-class work had to be produced very careful attention should be paid to this point. By adopting a recording gauge of the Bristol type, a complete record of the whole blow was obtained, but with the usual mercury or water gauges it was impossible to check a day's working unless an attendant was constantly recording the fluctuations. The amount of difference in the hardness of cast iron varied according to the type of cupola and the class of iron melted, and with different makes of cupola using the same mixture of iron different blast pressures had to be used to obtain the same degree of hardness. It would be readily seen that this method of modifying hardness by means of blast pressure was of great importance. The records which he had taken over a long period with the same sized test bar showed a range of hardness varying from an average of 48 with a 9-oz. blast to an average of 78 with a 17-oz. blast. While the chemical changes taking place between the extremes showed a decrease of total carbon of about 25 per cent., an increase of combined carbon of 1 per cent., and a very slight decrease of silicon—probably owing to this element being present in small proportion. These results would be only comparable for castings of about the same thickness. If, however, the castings were only, say, ¾ in. thick, then metal which gave the soft results would give the stronger castings; and, *vice versâ*, the harder irons would give the strongest castings when the thickness was, say, 2½ in. It must also be borne in mind that the relation shown by these tests between strength and hardness was only true with irons of similar composition, it being easy to obtain the same degree of hardness with an iron of very different constitution which would give a totally different tensile and transverse test result. But a variation in blast pressure would always be on the lines indicated.

The difficulty experienced with spongy places which leaked under water test pressure generally happened where several walls of metal met at or near one point. It was often found that castings from the same pattern could be made for some time without giving trouble, and that then suddenly similar castings

failed to fulfil the desired test. That had been his experience, and although he had not been able to prove satisfactorily the cause of the phenomenon, it could be shown at once when an iron would cause trouble in this direction. Mr. Cook then explained his method of casting test bars in the form of the letter "K," as described by him in his Presidential Address last year, and gave views of the structures produced by breakage at the points of junction.

Probably it would be thought that to carry out daily all the tests he had mentioned must consume a large amount of time. But this was not the case with proper organisation. In his foundry the whole of these tests were made every day as well as one for tensile strength. It was the duty of one boy to make each day a mould of the "K" test bars, also a mould of the ½-in. square bars. This gave the shrinkage, chill, deflection, transverse strength, and liability of the metal to sinking. The moulds, which took ten minutes to make, were deposited at an appointed place near the cupola, and the cupola attendant poured them at the proper time. Next morning the office boy got out the test bars, made the tests, and recorded them in the test book, and also changed the blast pressure chart, all of which he could easily do in a quarter of an hour. Thus, valuable information of the previous day's working was at once available. On each cylinder made there were cast three test bars, one for 1-in. square transverse test, one for tensile tests, and one for hardness. The castings storekeeper obtained first thing each morning a bar off one of the cylinders as it came out of the foundry, and sent it to the tool room to be tested for hardness, the result being obtained before the next casting time. The remaining two bars were wired on to the cylinder and delivered with it. Each day's cast was given a test number, and all the cylinders made under each test number were recorded in a book along with the results of all the mechanical tests, mixture, etc. In a similar book in the machine shop was recorded the history of each cylinder through the shops. Thus, as each cylinder when finished had the test number stamped on it a full history of each casting was always available.

It was also advisable to apply these tests occasionally to their regular brands of pig-iron, and by testing in a similar way any new brand they would have very reliable information for comparison. In conclusion, Mr. Cook referred to the important investigations that had been made during the past two years or so with a view to finding methods other than chemical analysis for determining the position and quantity of the various constituents of cast iron. He quoted the interesting results obtained by Mr Stead in connection with phosphorus and sulphur, and gave a practical illustration of the methods of detecting sulphur by means of gas light photographic paper soaked in a 3 per cent. solution of sulphuric acid. The method adopted for phosphorus, he explained, was to etch the surface with 30 per cent. nitric acid and examine under a low-power lens. The matrix would appear dark, and the phosphorus would stand out in relief white patches.

Discussion.

Mr. W. B. Parker (Rugby) said that he had seen a report with regard to Keep's shrinkage tests showing the shrinkage to a thousandth part of an inch. It had struck him that the machine could not be relied upon for such minute tests. He did not see how it was possible to keep the yokes clean and preserve a constant length so as to prevent the tests varying from time to time during the year. As to autograph records, they had had them in use for many years. Like Mr. Cook, he had never met a tester who was absolutely dishonest, but it was necessary to have an autographic record as a check, because the tester himself, like everybody else, was apt to make errors in observation. In using a testing machine he had noticed that as soon as the specimen was broken the weight took a distinct kick forward. when the test piece broke. On examining the weight he had found that the ball bearings upon which the weight moved had split. This might have gone on for some time without being observed, and a little thing like that, which interfered with correct observation, would be shown up in the diagram. The diagram defined the live weight on the specimen, and the kick was not shown in it, though it would be taken up by anyone reading off the machine.

Mr. C. Heggie suggested that Mr. Cook should tell them, seeing that there was really no chemical difference in the iron, in what way he would cure the defects which his physical tests revealed.

Mr. George Hailstone said he did not believe any chemist could mix iron successfully for producing castings with given properties by chemical analysis alone. There were other things to be taken into account. Two irons might be put before one exactly alike in every respect according to the chemical analysis, but one might be cold blast iron and the other hot blast. On examining these irons under the microscope, or even by comparing the fractures, they would be seen to be totally different irons. The reason, of course, was that with the hot blast iron the reduction in the blast furnace took place at a much higher temperature, and the size of the graphite was altered. In the hot blast iron the graphite was always very different from that of the cold blast iron. They had all heard that silicon was the important element in cast iron. A year or so ago he thought the same, but he had found out since then that it was not so. It was the actual condition of the carbon in the iron that gave the iron its strength and properties. Of course, phosphorus was added to get different strengths, but the real factor was the condition of the carbon.

The Chairman said that Mr. Cook had carried out his system in a very thorough manner. With regard to the relative merits of analysis and mechanical testing, there was a good deal of truth in what he had stated. It was of the greatest importance to know what elements went to make strong, or weak, or soft, or hard iron, and the more information they could obtain either on the chemical or on the physical side, the closer they were able to come to the composition and the structure of the iron, the more likely were they to be able to produce a class of iron they desired.

Mr. Cook, in reply, referred to Mr. Parker's remarks on the degree of accuracy in testing, and agreed with him that such minuteness as measuring to the one-thousandth of an inch was scarcely to be expected. As far as he was concerned he should think it entirely out of the question. One-hundredth of an inch was near enough for practical purposes. They had to gauge the yoke occasionally, but if they measured up to a thousandth of an inch a little bit of sand or oxidisation would throw them out. With regard to Mr. Heggie's question, as to the manner of curing the defects when discovered, the only way if their castings came out badly was to test each iron by itself. It would be worth while to melt down 10 or 15 cwts. in order to see whether that particular iron yielded satisfactory results. The only way was to test the irons and give up the one that gave trouble. He quite agreed with Mr. Hailstone that silicon was not the most important factor in the physical conditions of castings. It was entirely a question of the physical condition of the carbon. Silicon was important in its effect on the condition of the carbon, but they could not get away from chemical analysis.

and as the Chairman said, if they knew the direction in which the various elements would act upon the carbon they would be able to get a very good idea of the direction in which to work when making up mixtures from analysis. It was a point which was not emphasised enough in discussions of that kind that the physical properties of a casting entirely depended upon the condition of the carbon. He showed that in a paper he read a little while ago on the rate of cooling.

On the motion of the CHAIRMAN, a hearty vote of thanks was given to Mr. Cook for his lecture.

Birmingham Foundrymen.

Inspection of the New University Buildings.

The members of the Birmingham Branch of the British Foundrymen's Association, on Saturday, June 5, had the privilege of viewing the new buildings of the Birmingham University, at Bournbrook, in which considerable progress has been made since the visit of the Branch last year. The party included many lady friends of the members, and numbered over 200. Among those who took part in the visit were Mr. R. Mason (President of the Branch), Mr. F. J. Cook (President of the National Association), Mr. Buchanan (Past-President), and Messrs. H. L. Reason, F. Hamel (a visitor from America), G. Hailstone, D. Dalrymple, E. Buckler, J. Bullock, J. Grant, F. Baugh, F. E. Walker, F. E. Robinson, H. Winterton, Gale, J. Matthews, C. Heggie (Hon Secretary), etc.

The visitors were received by Professor T. Turner and Professor Dixon. Professor Turner gave a general account of the scheme of the buildings, and the party were then conducted round some of the principal departments under the guidance of Professors Turner and Dixon and Mr. O. F. Hudson. The Great Hall, with its lofty proportions, its memorial windows and its organ, excited much admiration, and was an object of special interest in that it will be the scene of the principal ceremony when the King and Queen come to open the University on July 7. The provision for the administrative department and other general purposes in the main block was seen to be ample and complete. Passing again through the imposing entrance hall under the dome, the visitors proceeded to inspect the rooms set apart for the professorial staff, and for special study and research, including the testing rooms and laboratories and workshops of the metallurgical department, the shops of the engineering department and the wood-working shop, where pattern-making is taught. In passing from one department to another the visitors made a detour in order to visit the gallery in which is to be seen a collection of ores, cokes, metals, and alloys, which for variety and for the rarity of some of the specimens is believed to be unsurpassed by that of any other educational institution. After a visit to the splendidly equipped electrical department and power station, the visitors came to the part specially interesting to them, namely, the foundry, the principal equipment of which is an open-hearth steel plant, the University being one of the few in the world which give students an opportunity not only of seeing steel made, but of taking part in the operation. Having inspected the moulding shops, a number of the visitors were allowed to view the new 300-ton testing machine which has just been installed as part of the equipment of the engineering department. The construction and uses of the machine were briefly explained by Professor Dixon. This testing machine we describe and illustrate elsewhere in this issue.

The visit concluded with tea in the students' refectory, the arrangements for refreshments having been made by the Committee of the Branch. At the conclusion, Mr. Buchanan, in the name of the visitors, thanked the University staff, and particularly Professors Turner and Dixon, for the privilege which had been enjoyed of seeing the new buildings and the provision made for instruction in subjects in which the members of the Association were particularly interested.

Professor Turner, in reply, said that it gave the staff of the University great pleasure to receive members of such an Association, and they trusted that when the Convention met in Birmingham in August they would be able to meet a still larger party of the foundrymen. On that occasion, no doubt, they would find the buildings still more attractive as the work would be much nearer completion.

Professor Dixon also acknowledged the thanks of the visitors, and associated himself with the words of welcome spoken by Professor Turner.

SILICON-CALCIUM-ALUMINIUM ALLOY.—An alloy is being introduced in America by Messrs. C. W. Leavitt & Company, of New York City, the analysis being approximately silicon 47 to 57 per cent., calcium 15 to 25 per cent., aluminium, 2½ to 6½ per cent. The two chief applications of this alloy are as an energetic deoxidiser and for securing a better desulphurisation. The two elements most useful for the deoxidation of a metal (silicon and aluminium) are included, and also calcium, which is a very energetic reagent. It is claimed that when added into the ladle it calms the steel and facilitates the production of sound ingots. The products of the reaction are double silicates of calcium and aluminium, which have a low melting point, the slag rising to the surface of the steel. This alloy is said to give better results than aluminium alone, even when it is added into the ingot mould itself, because it forms a very easily fusible slag which disengages from the steel. The alloy may be introduced either into the furnace a short time before tapping, or into the tap-hole during the tapping, or even into the ingot mould instead of aluminium or together with aluminium.

American Foundrymen's Association.

Annual Convention: Cincinnati.

In our last issue we gave some particulars of the joint Convention of American foundrymen, embracing the American Foundrymen's Association, the American Brass Founders' Association, the Associated Foundry Foremen, and the Foundry Manufacturers' Supply Association, and a number of the papers read were also published. In addition to a number of other papers which were given, we present herewith further particulars of the discussions and proceedings.

The attendance at the Convention is estimated at over 2,000, and 1,800 of these received the official badge as member or guest. Contrary to the procedure of last year's meeting, joint sessions of the American Foundrymen's Association, and the American Brass Founders' Association were held. At the opening session the report of the Committee on Industrial Education was read by Mr. P. Kreuzpointner, Chairman of the Committee. A resolution was passed commending the work being done by the public schools of Cincinnati in the furtherance of industrial training. This report will be found in our last issue.

New Officers.

The officers elected for the ensuing year were as follows:—

American Foundrymen's Association.

President, Arthur T. Waterfall, Russel Wheel and Foundry Company, Detroit.

Vice-Presidents: 1st district, F. E. Farnsworth, McLagon Foundry Company, New Haven, Conn.; 2nd district, Walter Wood, R. D. Wood & Company, Philadelphia, Pa.; 3rd district, Joseph T. Speer, Pittsburg Valve Foundry and Construction Company, Pittsburg; 4th district, Eugene W. Smith, Crane Company, Chicago; 5th district, Thos. W. Sheriffs, Sheriffs Manufacturing Company, Milwaukee, Wis.; 6th district, Alf. E. Howell, Phillips & Buttorf Manufacturing Company, Nashville, Tenn.; 7th district, William Gilbert, Buckeye Foundry Company, Cincinnati, O.; 8th district, A. F. N. Clare, Clare Stove Company, Preston, Ont.

Secretary and Treasurer, Dr. Richard Moldenke, Watchung, N.J.

American Brass Founders' Association.

President, William R. Webster, Bridgeport Brass Company, Bridgeport, Conn.

Vice-Presidents: (Rolling mill department).—Ed. O. Goss, Scovill Manufacturing Company, Waterbury, Conn. (Brass foundry, plating, and polishing departments).—A. H. Warner, Stebbings Manufacturing Company, Springfield, Mass.; W. L. Abate, Nathan Manufacturing Company, New York City; Thomas Evans, Eynon & Evans Manufacturing Company, Philadelphia; L. W. Olsen, Ohio Brass Company, Mansfield, O.; J. N. Gamble, National Tube Company, Kewanee, Ill.; W. D. Allen, Allen Manufacturing Company, Chicago; J. Cessna Sharp, John C. Sharp Brass Works, Chattanooga; N. K. B. Patch, Lumen Bearing Company, Toronto, Can.; Richard R. Mitchell, R. E. Mitchell Company, Montreal, Que. Secretary and Treasurer, W. M. Corse, Michigan Smelting and Refining Company, Detroit.

Associated Foundry Foremen.

President, Eugene W. Smith, Chicago (Crane Company).

First Vice-President, W. F. Grunan, Erie, Pa. (Erie City Iron Works).

Second Vice-President, J. L. Marshall, Milwaukee (Geo. H. Smith Steel Casting Company).

Secretary and Treasurer, C. E. Hoyt, Lewis Institute, Chicago.

Foundry and Manufacturers' Supply Association.

President, F. N. Perkins, Arcade Manufacturing Company, Freeport, Ill.

First Vice-President, F. B. Stevens, Frederic B. Stevens, Detroit.

Second Vice-President, R. S. Buch, A. Buch's Sons Company, Elizabethtown, Pa.

Third Vice-President, S. T. Johnston, S. Obermayer Company, Chicago.

Fourth Vice-President, Wm. Lodge, Lodge & Shipley Machine Tool Company, Cincinnati; Secretary-Treasurer, C. E. Hoyt, Lewis Institute, Chicago.

Trustees, three-year term.—E. A. Pridmore, H. E. Pridmore, Chicago; George H. Wadsworth, Falls Rivet and Machine Company, Cuyahoga Falls, O.; H. R. Atwater, Osborn Manufacturing Company, Cleveland, and E. J. Woodison, Detroit Foundry Supply Company, the last-named being elected to fill the unexpired term of S. T. Johnston.

According to custom, Mr. L. L. Anthes, the retiring President, was made an honorary life member of the American Foundrymen's Association.

Invitations were read by Mr. Frank T. F. Stephenson, inviting the Association to meet in Detroit in 1910, and by Major J. Speers, inviting the Association to Pittsburg in 1911, and both these invitations were referred to the Committee.

Committee on Castings.

Mr. John Jermain Porter, of the University of Cincinnati, who read a paper on "The Practical Value of Chemical Standards for Iron Castings," was appointed Chairman of a Committee, with power to select his own associates, for the purpose of classifying castings according to the physical properties which are of importance in them, and then to tabulate the chemical compositions which are found suitable for each class.

Committee on Standard Specifications.

Mr. H. E. Field, the Chairman of this Committee, presented the report which we published in our last issue. In the discussion of the report exception was taken to several features by Mr. E. A. Kebler, particularly the requirement that the gravimetric method be used for sulphur. The adoption of this method, he stated, was a most serious change from the usual practice, the volumetric method was in general use in foundries and furnaces. The gravimetric method should not be adopted as a standard until the foundrymen were willing to receive an apparently higher sulphur content in the iron than is specified in their contract. In addition, he said, it had not yet been proven that an iron which showed volumetrically sulphur 0.045 and gravimetrically 0.055 was a poorer iron than one which showed 0.045 by both methods. In proposing a specification it should be borne in

mind that pig-iron was made by charging large quantities of ore, limestone, and coke of varying analyses in the top of a furnace and this was not seen until it ran from the bottom as molten pig-iron, and even with the best skill that could be purchased there would still be a great variation in the product, and if specifications were drawn so closely that only a small portion was considered standard, this must be sold at a relatively high price to offset the lower price at which the balance must be sold, because under the proposed gravimetric specifications this balance might be penalised on account of high sulphur shown. Under the percentage and variations table an allowance in silicon was permitted of 0.25 either way. If this table were adopted as shown, and a customer ordered 2 per cent. silicon and a car of iron analysing exactly 2 per cent. were shipped on the order, the customer might pay for this as under contract price or at the price of 2.25 silicon or at the price of 1.75 silicon, as this determination would come in the first instance exactly on the standard and in the last two cases within the allowed variation of the other two grades. This same suggestion, he continued, applied to the manganese where the allowance was exactly the same as the difference between the different grades. As carbons are very rarely determined, it would be well to omit the carbon from the specifications.

Mr. E. J. Stoddard, of the Detroit Testing Laboratory, said it was unnecessary to split hairs in the average foundry over a 5/1,000 in the sulphur, and inasmuch as nearly all commercial laboratories used the evolution method, he disapproved the idea of specifying any method. Furthermore, foundrymen would not pay for a gravimetric determination.

Dr. Moldenke replied that merely because a method was in general use was no reason why the Association should sanction its continuance when it knew the same was wrong. He said there ought to be two prices for the volumetric and gravimetric. To this Mr. Stoddard answered that it was enough to collect for the present relatively cheap system.

Mr. Field, Chairman of the Committee proposing the specifications, in answer to the objections raised to the report, said:—"The Committee recognised the fact that the slight extra expense would be caused the furnaces in adopting the gravimetric method and gave this due consideration, but considered that this extra expense was absolutely necessary. Every iron differs in the proportion of sulphur that is evolved. This difference is practically constant in each brand of iron, and it would be very little trouble for the furnace to fix its own differential and sell on the gravimetric basis. It could analyse its iron volumetrically and have a gravimetric method by its own chemist or by some reputable chemist once in a while. The specifications submitted took this into account and made the gravimetric method optional with the signers of the contract. Should the founder be assured that the iron he was buying gave all the sulphur by the evolution method, he could accept the evolution method in the contract. This question is so important that the Committee gave months of consideration to it, and came to the conclusion that the only way of making the specifications in any way suitable and lasting was to adopt the gravimetric method. In regard to the question of variation in silicon mentioned by Mr. Kebler, the questions in the final report will take care of these.'

Major Speer, of Pittsburg, believed the report ought to be adopted, and if the commercial chemists could not make a gravimetric analysis, they should be educated to do so.

The report was then adopted, the negative votes cast being from representatives of laboratory and pig-iron interests.

A *Steel* Founders' Section.

The Secretary, Dr. Moldenke, brought up a suggestion that had been made for the formation of a separate section or association for steel foundry interests, similar to that now existing for the brass foundries. It was decided to ask the Executive Board to take the matter under consideration and ascertain whether the steel foundry industry would favour the formation of a separate association for the reading and discussion of papers.

Brass Founders' Committee.

At the business meeting of the Brass Founders' Association, a Committee on Standardisation was appointed, consisting of Messrs. W. M. Corse (Secretary), E. S. Sperry, Bridgeport, Conn., and A. D. Little, Boston. This Committee was charged particularly with the formulation of standards for the analysis of brass and other alloys. Dr. W. F. Hillebrand, representing the United States Bureau of Standards, was present at the Convention, and met with the above Committee to lay out plans for the work. Mr. Corse represented the American Chemical Society, as well as the Brass Founders' Association on the Committee, the former Society having promised co-operation in the work.

DISCUSSION ON THE PAPERS AND REPORTS.

We summarise in the following the discussions which were contributed on the various papers read before the Associations. Some of the papers will be found in this issue, but a number of them appeared in our last.

The *Side*-Blow Converter for Steel Castings.*

In the discussion on this paper, Mr. Whitehouse, questioned as to the reason for using scrap, said this was to keep the metal from getting too hot, as very hot steel causes burning of the sand and makes the castings hard to clean. The question was raised whether there would not be difficulty in pouring a full heat from the bull ladle when using 1.25 per cent. silicon iron in the charge. Mr. Whitehouse said that in his practice at Everett, Mass., he had had no trouble with such iron, and had poured heats running not over 1 per cent. in silicon. In his present practice he is pouring full heats for castings under 30 lbs. from a batch of 1,000 lbs. of steel in the ladle. He said, also, that he had discarded upper tuyeres altogether.

Open-Hearth Methods for *Steel* Castings.*

This paper, in the absence of Mr. W. M. Carr, the author, was read by the Secretary. A number of questions were asked, showing considerable interest in the possibilities of an open-hearth furnace making heats of from 500 lbs. to 2 tons. Dr. Moldenke said he had attended the recent convention of the American Electro-chemical Society at Niagara Falls to learn what the foundry may expect from electrical furnace developments. Plants located in out-of-the-way districts where water-power is available do not meet the case, he said. What the founder wants is a practical means of producing steel castings cheaply in a plant auxiliary to the iron foundry. The speaker considered the electrical production of steel as now developed too expensive for the foundry. If nine-tenths of the work in the manufacture of steel castings could be done cheaply, it might be possible to use electricity for the remaining one-tenth, as it makes fine steel. Mr. T. J. Best asked as to the possibilities of manufacturing small castings of steel, and it was replied that at one plant steel castings, 20 to the pound, were being made, though this was in conjunc-

* See F.T.J. last month.

tion with heavier work which could be poured from colder metal.

The Use of Pulverised Coal for Foundry Purposes.*

This paper was presented in brief abstract by Mr. R. K. Meade. To the question whether pulverised coal had been used in the cupola, Dr. Moldenke replied in the negative, but added that in Germany oil had been used in the cupola. His own experience had been that unless the air was pre-heated there would be trouble with the use of the oil jet. He had witnessed some experiments in a Chicago foundry, where it took 1 hour to melt 1,000 lbs. of iron with oil, whereas ½ hour was long enough.

The Cost of Steel Making in Foundries.

This paper was presented by Mr. Bradley Stoughton, New York, and is given elsewhere in this issue. Answering the question whether the electric furnace could be used for the refining of iron after melting in the cupola, Mr. Stoughton said this could doubtless be done in a large electric furnace, and the cost would be less than if metal were taken from the converter and then refined electrically, but not very much less. Another member asked whether the allowance for operating costs in Mr. Stoughton's tables included overhead charges and the expense of selling. It was replied that this item as given included repairs, depreciation, and interest on investment, but not office expense, insurance, or selling cost.

Continuous Melting in the Foundry of the Westinghouse Air Brake Company.

This paper appears on another page of this issue.

Mr. Sleeth was subjected to a steady fire of questioning which brought out more details of the system followed at Wilmerding. The mould conveying table travels at the rate of 21 ft. a minute, which allows time for the setting of cores by workers who walk alongside the moving table. The pourers get on the platform with their ladles and move with it. Small castings are poured on this table and the melt of iron is 52 tons a day. The question came up as to what amount of work should be put through the foundry in a day to make continuous moulding and pouring economical. Mr. Sleeth expressed the opinion that 40 to 50 tons would be required. The economies of the system, he explained, consist in getting back the sand in 20 minutes after the castings are taken out, in getting back the flasks promptly and in the repeated use of sand and flasks on the same conveyor. Regarding the management of the cupola, it was stated that upper tuyeres are used only part of the time, and the speaker could not recall when they had been used continuously through a heat. It was found that the bottom dropped about as well after a long stretch of melting as though there had been but three or four hours of it. In the operation of the conveying table it was said that the displacement of sand in the mould due to the motion gave very little trouble. The brass founders present were interested in knowing whether the system could be applied to their work. Mr. Sleeth said that it was not used in the brass foundry at Wilmerding, though so far as the conveying system goes he thought it could be applied to brass as well as iron, and that continuous pouring would work also in the brass foundry. He doubted the feasibility of using continuous melting in a foundry turning out different classes of castings in the same day, as continuous melting gave but one kind of iron.

A question was asked as to the amount of iron that could be secured from the cupola under continuous melting. Mr. Best said that from his experience it was possible to get 60 tons a day from a 36-in. cupola.

The following written contribution to the discussion was made by G. K. Hooper, 165, Broadway, New York: —

"A question was put as to on how small a tonnage continuous melting could be made to pay? Mr. Sleeth answered that this depends upon the work in any particular foundry. The tonnage has less influence on the economies to be gained by operating continuously than the number of moulds to be handled, as it is at once apparent that a few moulds may contain a large tonnage to which continuous methods would be entirely unsuited, while a less tonnage frequently is distributed in a very large number of flasks, the handling of which, with the sand, castings, cores, etc., would undoubtedly yield large economies if carried on mechanically and continuously. The mould, therefore, is the unit which must be used when considering whether the continuous method can be applied to any particular production.

"Again, Mr. Sleeth was asked if the hot sand has any effect in causing loss of castings. His answer very truly was that generally it has no such effect if the pattern plate be suitably warmed, and he spoke of a 20-minute period as the time in which his sand is in circuit. I may say that by means of large cooling and mixing riddles it is possible to considerably shorten this time and consequently the amount of sand handled, and I am familiar with systems where the sand is actually in use again in a much shorter time than this. The first system with which I had to do had the sand in transit less than 3 minutes from the time when it was dumped out hot, riddled, cooled, tempered, mixed, and again deposited in the hoppers over the machines for reuse, going again into the mould within another three minutes.

"As to methods of handling moulding sand by means of conveyors, in my experience belts are the most suitable for this purpose. Canvas belts can be efficiently used where the sand is dry, as in shaking out or dumping conveyors, but with tempered sand a rubber belt is preferable, as the sand will more freely discharge from it and the moisture of the sand will have less effect on the belt surface. Flat belts are superior to troughed belts for this service and wide belts moving slowly better than narrow fast running belts.

"A drag or scraper conveyor may be used in distributing sand to hoppers over moulding machines, and is, in fact, the best device for this service, and it also should be large and slow moving, both to avoid wear and to preserve the condition of the sand, since the tempered moulding sand has a tendency to "ball," and once in that condition must be crushed or dried to again render it suitable for use. The drag conveyor is preferably made with a wooden trough and wood conveyor flights. Netting on riddles and sieves is preferably made of phosphor bronze wire, and top bolts and nuts on apparatus requiring renewals should also be of bronze.

"Mr. Sleeth was further asked if any damage is noted to moulds from the movement of the mould conveyor, to which he suitably responded that none is noticed. This would, in fact, be predicated by the fact that the foundry loss in these systems is generally less than in floor work; but I can go a step farther than this and say that moulds may be subjected to what would be considered very rough treatment and yet suffer no damage, as I have repeatedly loosened up all connections on a mould conveyor and shaken the car conveying a mould with all my strength while it was being poured, banging the carriage against its supports hard enough to slop the iron out of the sprue and found no apparent defect by sufficient commercial test in the casting.

* See F.T.J. last month.

"The operation of the cupola was also touched upon. My experience goes to show that this is perhaps the most easily managed function of the whole system, since, if the blower—and I think the positive blast blower is best for the purpose—be driven by a direct connected engine with its valve easily accessible from the pouring platform, great variations in melting speed may be obtained with little detriment to the quality of the iron, and by thus handling the blower and having means of communicating at the same time with the charging floor, the cupola may be easily held for considerable periods, such as for changing patterns, etc., and operation started immediately when desired. I have spoken of stopping for changing patterns on purpose, as there is little need for extended stops on any other account, as a suitably designed system will operate on less than 2 per cent. loss of running time from accidents.

"I am a little surprised to find among foundrymen, otherwise so well informed, an impression that this continuous method is in an experimental stage. Nothing could be farther from the fact as the method is so aged that the 'mother' patents upon it have expired, and the former owner of them tells me that his original system has been running for 18 years and is still in use. There are a sufficient number of plants in successful and every-day operation to put the scheme entirely out of the class of experiment."

Permanent Moulds.*

This paper, by Mr. E. A. Custer, proved of very considerable interest. Inquiries were made as to the number of castings that could be made from a single mould, and as to the interval between one use of the mould and the next. From a mould shown on the screen it was stated that 4,000 lengths of soil pipe had been made in seven months with the mould apparently as good as at the beginning, except for a few slight cracks on one of the gates. In the experience of the author, it was found possible to take a casting from each mould every 40 seconds. A liberal amount of gating must be provided, rather more than in ordinary sand castings. Some of the brass founders asked whether the permanent mould might be applied to their industry. A Western firm reported that it had been experimenting on permanent moulds in the brass foundry, but found that they warped after a few castings had been made. The remedy, according to Mr. Custer, is to put considerably more metal into the mould. It was also suggested that in brass casting some parts of a permanent mould should be of a substance other than iron so as to radiate the heat faster than from other portions. The casting of copper anodes in copper moulds was referred to. Here the radiation of heat is so rapid that the copper in the mould is not brought up to the fusing point.

On the question of chilling Mr. H. M. Lane, Cleveland, remarked that the secret of avoiding chilling lies in removing the castings from the permanent mould at a temperature above the recalescence point and just below the point at which the casting sets. Mr. Custer said that the ultimate shrinkage of castings made in permanent moulds was almost the same as that for castings made in sand moulds. Chilling is avoided in part by the prompt removal of the casting on setting, and by the selection of the pig-iron. If an iron chills in a sand mould it will chill on being cast in the permanent mould. Asked as to the limit of silicon in the pig-iron to insure against chilling, he said that he would put it at 1.75 per cent. with sulphur below 0.05 per cent. The results secured in the chilling of molten iron swiftly to the point of setting and then allowing it to cool gradually were of special interest to the members of the Convention. Mr. Custer showed specimens of iron treated in this way. Chemically they had the characteristics of cast iron with the exception of combined carbon, and had also some of the properties of high carbon steel. He showed a piece of cast iron containing 0.44 per cent. combined carbon and over 2 per cent. free carbon which had been tempered repeatedly; and yet the common teaching is that steel will not take a temper if it contains an appreciable amount of free carbon. A plough point was shown which had been cast in a permanent mould and then plunged in water. The edge was white with a backing of grey iron.

* See F.T.J. last month.

Chemical Standards for Iron Castings.*

This paper was brought up at the closing session of the Association on Friday morning, preceding the business session. The author suggested that the Association undertake to classify castings according to the physical properties which are of importance in them and then tabulate the chemical compositions which are found suitable for each class. It would also be desirable to show where possible how the foundryman could cut down the cost of iron without decreasing the quality of his product.

The Secretary, Dr. Moldenke, said that a good many requests came to him for mixtures adapted to certain classes of castings, and he believed Mr. Porter's plan might help inquiring foundrymen. Mr. Porter was thereon, as previously stated, appointed chairman of a committee for the formulation of chemical standards for iron castings.

Waste Heat in Brass Foundries.

A brief paper on this subject was read by Mr. F. W. Reidenbach, general manager of the Genesee Metal Company, Rochester, N.Y. He suggested that with the large number of foundries that are today using special oil-burning furnaces a vast amount of heat is being lost. At the works with which he is connected a steam heating plant is maintained which cares for the Company's offices with the waste heat of only two No. 200 crucible furnaces, resulting in an annual saving of £60 in fuel.

In the discussion one member suggested that before the materials used in the brass foundry are brought to the melting point 80 per cent. of the heat units go up the chimney. Another asked whether gases coming from melting furnaces do not affect the boiler tubes. Mr. Reidenbach said that occasionally a tube cracks, but the damage from this source is not enough to be considered. The fouling of tubes with zinc where alloys containing a large proportion of zinc are melted was spoken of as likely to reduce the efficiency of the boiler, but it was said that such scale can be readily removed with a wire brush.

Pyrometry in the Brass Foundry.

In his paper on "General Principles of Operation of Industrial Pyrometers," Mr. C. H. Wilson claims that brass founders have not shown much interest in the pyrometer, whereas steel works engineers have met the pyrometer manufacturers half way, with the result that for the steel industry heat measuring apparatus has reached a high point of development. In brass melting the great need, which has not yet been met, is such an inclosing tube as can be put in molten brass and will stand up continuously, so that reliable results can be secured without frequent renewals and repairs.

Melting Brass Turnings in the Oil Furnace.*

In the discussion on this paper it was stated that practice varies widely as to the oil and air pressure used with brass melting furnaces. The air pressure of 7 lbs. used by the writer of the paper was questioned by some members, who employ scarcely more

* See F.T.J. last month.

than that many ounces of pressure. One member referred to practice in which 45 lbs. oil pressure and 14 to 16 ozs. air pressure were used with a tilting crucible furnace. Another mentioned 20 ozs. air pressure with each of the two types of brass melting furnace used in his foundry. Still another, who had gravity feed for oil, created surprise by saying that he used 45 lbs. air pressure, taking air directly from a compressor line. Originally he had throttled this down to a few pounds, but found better results in using it direct. General agreement was expressed as to the desirability of a furnace that will give a reducing flame.

Mr. Corse emphasised the claim made in the paper that better castings are secured by using remelted metal. Where castings for steam or hydraulic pressures are desired, remelted metal is to be preferred, since the oxide of zinc and other impurities have a better chance to come out.

Tensile Strength of Aluminium Zinc Alloys.

A paper, by Mr. W. D. Bancroft, on this subject was read by Dr. Stephenson. It detailed experiments conducted by the writer. In practice it has been found that alloys of about 75 per cent. aluminium make sharp castings, with low melting point and fair strength. The sharp castings are due not so much to expansion on cooling as to superior casting properties of the metal. The only previous systematic investigation of the aluminium-zinc alloys was carried on by Professor R. C. Carpenter. Only fourteen pieces were subjected to tension tests, and, as the latter were not conclusive, the author's investigation was undertaken. He found that the values obtained from alloys of from 50 to 70 per cent. aluminium depend to a large extent upon the rapidity of cooling. Professor Carpenter's values were generally lower than those in the writer's tests, except when the test pieces approached the pure aluminium end of the series. Here Professor Carpenter's results were higher. Most of the alloys tested by Mr. Bancroft showed strength of from 25,000 to 35,000 lbs. per square inch, whereas Professor Carpenter obtained 25,000 lbs. as a maximum.

Continuous Melting in the Foundry of the Westinghouse Air Brake Company.*

By S. D. Sleeth.

When the Westinghouse Air Brake Company found it necessary to enlarge their plant, on account of increased business, it was decided to move to Wilmerding, Pa., and instal in the foundry flask and sand conveyors. This meant that the foundry would have to run so that iron could be poured all day, instead of two or three hours in the afternoon. We knew of no plant where this was being done, so it was necessary for our foundry to work it out. As it required about two and one-half hours to run the heat off at that time, we decided to see how much longer we could hold the metal in the cupola and still keep it hot. The first day we put the blast on one-half hour earlier and melted the iron with the same blast pressure, but would shut the blast off for five or ten minutes, and then start to blow again. This we found to work satisfactorily for that day. The second day we put the blast on one hour earlier, but this did not work so well, we therefore added more coke, which kept the metal hot, though the melting was slower.

When we started work in the new foundry at Wilmerding we ran two cupolas, one in the morning and one in the afternoon. We were afraid to hold over the dinner hour. After running for some time in this way we decided to run one cupola all day, and at 11 o'clock, or a little later, we added 200 lbs. of coke for two or three charges so that we would have an extra amount of coke to hold over the dinner hour. The cupola man insisted that the iron would freeze at the tapping hole, but we finally persuaded him that he would not be held responsible should this occur. We drained all the iron out at 12 o'clock, closing the slag hole with sand, stopping the tapping hole, and shutting all other openings tight, so there would be no draft. About ten minutes before starting time we tapped out all that was in the cupola and pigged it, then put the blast on full, so as to be ready when the starting whistle blew. We now have sometimes to pig 200 or 300 lbs. on acount of the metal not being hot enough.

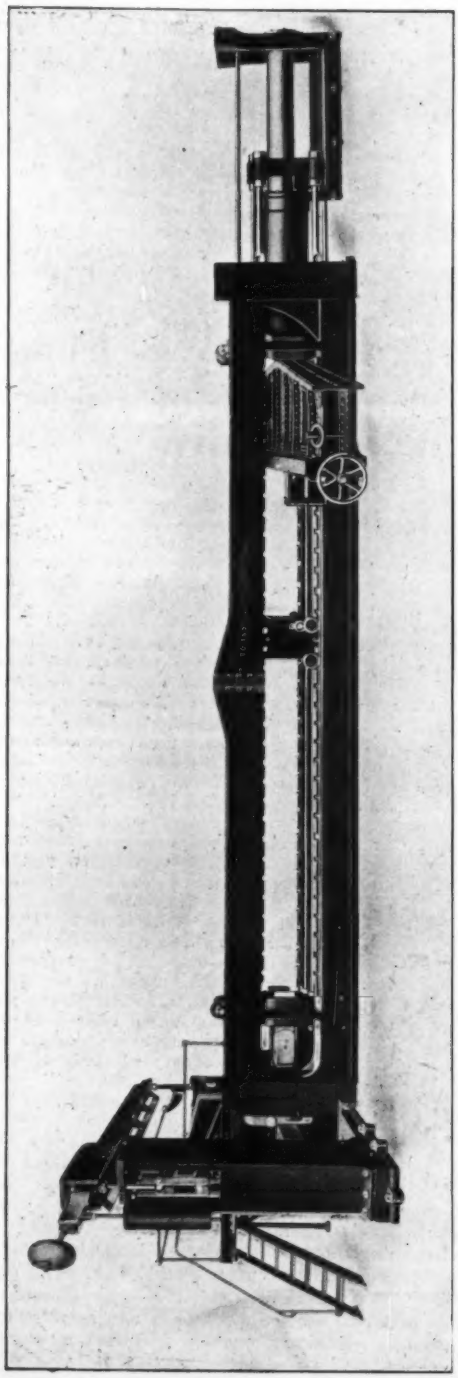
We had two sizes of cupola—48 in. and 60 in. inside the lining and when the heats were heavy we would run the 60 in. cupola. We had to enlarge the plant again, so we took out the 48-in. cupola and installed two new ones, the shells being 90 in., so that we could line them up to 78 in. if required. We have them lined at the present time to 70 in. When running full, *i.e.*, night and day, we melt 280 tons, running each cupola about ten hours. We have operated one cupola from Friday night at 6 o'clock until Saturday noon of the following day, closing down at 11 p.m. for one-half hour for lunch, and again at 6.30 in the morning for three-quarters of an hour for breakfast. This is rather hard on the lining so we do not make a practice of it.

We have tried a great many experiments with cupolas, but as yet have been unable to find any system that will give better results than the double row of tuyeres—the upper row about 10 in. above the lower. It is not necessary to keep the upper ones open all the time. Our blast pressure is about 11 ozs. in the cupola bustle, and we use a fan for blast. When running full we melt 10 to 11 lbs. of iron to 1 lb. of coke. In charging the cupola we are very careful to have the charge level. We charge the pig by hand, and the scrap is dumped in from a bogey through a door above the regular charging door, all the charges being the same from beginning to the end of the heat. As the iron must come very soft and uniform we do not charge more than 4,000 lbs. at one time. For a smaller cupola the charge would naturally be less.

From our experience I would advise as follows:—See that the coke bed is burning even all around, then charge just as you would for an ordinary run, allowing an extra amount of coke for the dinner hour. After running about one hour, open the slag hole and keep it open, except during the dinner hour. Use about 40 to 50 lbs. of limestone to one ton of molten metal—better to use too much than too little. Have the cupola shell large enough, as it is easy to put in an extra lining for smaller heats.

* Read before the American Foundrymen's Association, May, 1909.

The 300-Ton Testing Machine at Birmingham University.



300-Ton Testing Machine at the Birmingham University; Constructed by Messrs. W. & T. Avery, Ltd.

The Civil Engineering Department of the Birmingham University is now possessed of one of the largest testing machines ever constructed. The leading points of the machine are its high capacity and the size of the specimens it is possible to test. Not only can small specimens be tested, but complete members themselves, which render the test more valuable from every point of view. The necessity for tests of complete members of a built-up structure has long been emphasised by engineers, and should add considerably to our knowledge of the value of bracings and lattices, etc., as stiffening agencies in the construction of compression members.

The machine will also test ropes, chains, or bar specimens of the usual prepared or unprepared type, in tension up to a maximum stretched length of 33 ft. 6 in., while columns or stanchions up to a maximum length of 30 ft. can be tested in compression. The transverse test has received special attention, with the result that beams, built-up girders, or even roof trusses complete, can be tested up to the maximum load applied centrally between abutments set to any span up to 20 ft. apart. The maximum length of the beam or built-up girder in the transverse test is 30 ft.

It will be seen from the accompanying illustration that the machine comprises a massive cast-iron frame, consisting of the bedplate, with two vertical standards between which at the top are spanned two long horizontal columns acting as compression struts. The frame is so designed that it enables the operator to have a clear view of the specimen at each side for its full length, also the top of the specimen. This point is important when testing built-up members in compression, as it enables the buckling tendency of the lattices and bracings to be kept under close observation throughout the test. At the right hand of the frame is the hydraulic cylinder and ram for applying the strain, the weighing levers and steelyard being placed at the opposite end. The cylinder and ram are double-acting and arranged to suit a hydraulic pressure of 1,000 lbs. per square inch, a pressure of 85 lbs. per square inch being used both for returning the ram to its normal position after a test, and for applying test loads of small capacity. The large ram has a stroke of 5 ft. 6 in.; it is hollow, and works over a smaller subsidiary and stationary ram. For the straining stroke the hydraulic pressure is admitted behind the main ram, the return stroke being obtained by the pressure passing through the subsidiary ram.

The weighing or recording mechanism consists of two levers by means of which the test load is communicated to the steelyard. The main lever, which is of the bell-crank type, is a substantial steel casting, fitted with hardened steel knife-edges. The load and fulcrum knife-edges both conform to the Board of Trade Regulations, being 60 in. long, the large distance between them, *i.e.*, 12 in., enabling great sensitiveness to be attained. The lever is so disposed as regards the frame that the fulcrum knife-edge engages with a hardened steel bearing, fitted into a recess placed in the lower part of the bed. The second lever is fulcrummed upon a column standing upon and bolted to the bed, and its outer end is connected to the rear knife-edge of the steelyard by means of connecting links with hardened steel bearings. Each knife-edge is ground perfectly lineable, and in order to prevent side friction is provided with hardened steel nibs. The steelyard and poises were specially

made for this machine, as the object has been to dispense with loose weights, which are always objectionable when conducting scientific tests. In this steelyard there are seven poises, each of which, when moved to the full length of the steelyard, represents a 100,000-lb. load upon the specimen, and the operator standing at either end of the steelyard has control over the poises. In order to obtain the best testing results, the strain may be kept on the specimen and the steelyard be constantly in equilibrium throughout the test until fracture occurs.

The specimen in tension is secured at one end of a travelling cross-head, which is propelled along machined tracks upon the bed by means of gearing operated by a handle at each side. When in position to suit the specimen the cross-head is locked to four steel racks, which slide in machined grooves in the bed and the two upper columns respectively. The four racks are connected to the head of the main ram and partake of its motion, thus applying the strain to the specimen. The opposite end of the tension specimen is secured in a weighing cross-head, which is suspended by means of a knife-edge resting in hardened steel bearings upon the upper columns of the frame. This cross-head is connected by means of four mild-steel tension rods to a second cross-head at the other end of the bed, which is suspended, the whole weighing system of two cross-heads and four tension rods thus floating upon knife-edges; this arrangement ensuring the greatest possible sensitiveness.

The floating frame is connected to the main lever by means of massive steel forks fitted with a hardened steel bearing block, which engages with the load knife-edge of the lever. Compression specimens are tested between plattens attached to the travelling cross-head and the front face of the cross-beam used for transverse tests. For the longest specimen the cross-beam is removed and the column allowed to bear against the platten, which is then fitted into the cross-head. Two pairs of plattens for column tests are provided, one pair having fixed surfaces for tests with fixed ends. The second pair of plattens are of Avery's patent swivelling type, enabling "free end" compression to be made.

Transverse tests are made by placing the beam or girder to be tested across the two end pressure feet of the cross-beam of the tester and then causing the central presser foot, which is bolted to the front face of the travelling cross-head, to bear against the middle of the beam. The two presser feet upon the cross-beam are set to the required space by means of hand wheels at each end of the beam.

The machine is provided with a staircase and platform, upon which the operator stands to manipulate the steelyard poises, having at the same time under his control the valves by which the strain is applied. From this position also the operator has a complete view of the specimen while being tested. An autographic stress strain recorder is attached to the steelyard column and by connection to the specimen, and the gearing by which the poises are propelled respectively enables stress strain diagrams to be taken.

It will be gathered from the above that all the necessary requirements for scientific and up-to-date testing have been observed in designing this machine, and the Birmingham University are to be congratulated on its possession, and Messrs. W. & T. Avery, Limited, of the Soho Foundry, Birmingham, upon its manufacture.

Messrs. Tetley & Company, of Salford, have opened a London office at 577, Mansion House Chambers, 20, Bucklersbury. E.C., which they have placed under the management of Mr. H. C. Hodgson.

Casting Wrought-Iron or Steel Spokes in the Hubs or Rims of Castings.

By R. F. Walker.

For many years it has been the custom of agricultural implement makers and manufacturers of light machinery castings to put a coating of tin on the wrought iron or steel rods and strips placed in the hubs or rims of wheels or castings of a similar form, this being the only reliable way to ensure a good contact of the cast iron with the rods. Other methods have been adopted such as coating with red lead mixed with turpentine, or rubbing them with chalk. Both of these latter methods are very unsatisfactory in many cases because a greater insulation is produced between the cast iron and the wrought, therefore in a very short time the spokes work loose, and begin to rattle like a riddle full of nuts.

Why do these spokes or rods work loose? To begin with, there is the scale on the iron which was produced during forging on the skin of the wrought iron, and the metal requires to be of a very high temperature to dissolve it, which means ruin to the rod. If you don't melt the scale or oxide the cast iron will run round it and on contraction will separate it from the clean iron underneath with the result that with a little vibration and the aid of any free graphite that is present the spoke will work loose. Therefore if we add to the scale a coating of red lead or chalk we only increase the gap between wrought iron and the cast iron.

For four or five years the price of tin has advanced considerably, which means a great deal to users, and any substitute is eagerly sought for. For this reason I endeavoured to find a substitute for the tinning of some spokes. The surface area that required tinning was seven square inches on each one, the number being 12,000 annually. There being only $\frac{1}{4}$ in. thickness of metal round them, it was necessary that they should be firm. In the method I adopted, the spokes went through the process of pickling and washing as for tinning, but in place of a bath of tin, they were dipped into a boiling solution of soda water. This has a two-fold effect; it neutralised the acid, which also prevents the creeping action by means of which it collects the moisture present in the mould and deposits it in the form of dew on the spoke, causing a lot of trouble; also the boiling solution removes any free graphite that may be present, presenting a clean surface to the molten iron so that it is able to obtain a good grip. I have tried this method for three years and found it successful in every way. I have tried it in large internal gear wheels 2 ft. diameter, teeth $\frac{3}{4}$ pitch, 2 in. deep, having eight spokes cast in the rim or flange in close contact with the teeth, and not the least trouble has resulted, which fact speaks for itself. The above method applies to the spokes being used up as prepared each day.

Mr. H. V. Kramer, late managing director of Kramos, Limited, of Bath, has now severed all connection with that company, and has formed in conjunction with the Witton Engineering Works, Birmingham, the Witton Kramer Electric Tool and Hoist Company to carry on the manufacture and sale on a much larger scale of the electric suspension and mono-rail trolley hoists, electro-lifting magnets, electric portable drills and grinders, and brake solenoids, which he introduced when he formed Kramos, Limited.

International Congress of Applied Chemistry.

During the last week of May the Seventh International Congress of Applied Chemistry held its meetings at the Imperial Institute, London. The programme included, in addition to a great number of papers presented before the different sections and the discussions thereon, a number of social functions and visits. We present herewith abstracts of some of the papers, particularly those read before the Mining and Metallurgical Section, which will prove of interest to our readers.

ADDRESS BY SIR HUGH BELL, BART.

Sir Hugh Bell, Bart., who was chosen President of the Mining and Metallurgical Section for the opening day, gave an address, in the course of which he remarked that it might be truthfully contended that the development of the motor car had been productive of very remarkable effects benefiting the mass of the people. For its perfecting the motor car made a series of large demands on the metallurgist. Lightness was an essential quality, and resistance to strains and stresses of the most varied character was demanded. The finest alloys of steel were not too good for the purpose. A quasi-commercial demand was set up for these fine alloys, and the great economic law which governed such matters did not fail to provide the supply. But men, having found that ingenuity exercised in this particular direction would reap a golden reward, applied themselves to study on commercial lines metals which hitherto had possessed little interest outside the laboratory. The result was to be seen in the multiplicity of alloys which had passed into current use.

Amongst the alloy steels might be named those containing Mn, Ni, Cr, W, Mo, Va, Al, Ti, Ur, together with the metalloids C, Si, and B, and quaternary as well as ternary steels were used, amongst the more important being alloys with Ni and Cr, Ni and Va, and Cr and Va. Steels with 1.5 to 2 per cent. of Ni and 0.1 to 0.15 per cent. of C were used for the *chassis*, as also was a similar quaternary steel containing about 1 per cent. of Cr. For parts that required case-hardening, steel with Ni up to 7 per cent. was used, as also were Cr steels. Quaternary Va-Cr steel possessed considerable stiffness as well as elasticity, and was used where severe torsional stresses had to be resisted, *e.g.*, for the rear axles. For valves exposed to high temperatures steel with Ni up to 35 per cent. was used. A special alloy of Al and iron, known as Albidur, was used in motor-car work; it was one-fourth the weight of iron, and had a tensile strength up to 15 tons per square inch.

ALLOYS OF IRON, CARBON, AND PHOSPHORUS.

By J. E. Stead, F.R.S. (Middlesbrough).

The paper is partly a review of the published work of Wüst and others, but also contains evidence to show:—(1) That the eutectic of both grey and white phosphoretic pig-irons at the time of initial solidification is practically identical in composition. (2) That during the solidification, and the cooling down afterwards, of pig-irons which are white when cold, the ternary eutectic containing about 2 per cent. carbon and 7 per cent. phosphorus remains as such in the cold metal. (3) That the eutectic when still liquid in grey pig-irons is practically the same as that in white iron, but, during solidification and afterwards, when cooling down, the carbon diffuses out of it, and there remains in the cold metal a binary eutectic of iron and phosphorus practically free from carbon. This was proved by expressing, by hydraulic pressure, the eutectic from the nearly solidified metal, analysing what was squeezed out, and by examination of the corresponding grey iron under the microscope. (4) That as the phosphorus is increased in steel castings and ingots, when the carbon is between 0.10 and 0.5 per cent. the ferrite enveloping the crystals increases proportionately in volume, and that the phosphorus is always higher in these envelopes than in the portions of the crystals which first solidified. (5) That whilst the phosphorus and carbon segregate round the crystals in the metal which solidifies last, the carbon during cooling down diffuses out of the envelopes into the parts of the crystals which were initially nearly pure iron, and is concentrated there. (6) That rolled steels containing little carbon, such as boiler plates, etc., almost always contain bands of ferrite free from carbon, and strings of particles of pearlite embedded in ferrite also in bands. The white bands have been called microscopic "ghost lines." They represent the elongated envelopes of ferrite which surrounded the crystals in the cold cast steel, and are higher in phosphorus than the pearlite bands. This banded condition is normal in commercial soft steels in the rolled condition, and, judging from the result of much research, cannot be avoided without almost entirely eliminating the phosphorus. The white bands are more pronounced the higher the phosphorus.

ELECTRIC IRON SMELTING IN FRANCE.

By M. Clausel de Coussergues (Paris).

The electric iron-smelting furnaces are, with the exception of the two induction types—the Schneider-Saladin furnace at Creusot and the other at the St. Jacques Works at Montlucon—of the arc type, including the Chapelet system at Allevard, Héroult furnaces at La Praz and le Saut du Tarn, Girod furnaces at Ugines, their own furnaces at Firminy, their own furnaces at Imphy, and the Keller furnace at Unieux. The confidence shown in the practice is indicated by the fact that such furnaces are at work up to a capacity of two tons at Ugines, and three and a half tons at Allevard. When possible, waterfalls supply the power—that is at Allevard, La Praz, le Saut du Tarn, and Ugines; elsewhere heat engines are used to produce the electric energy. The duty demanded from the electricity is different in the two cases; in the first instance ferruginous material is charged into the furnaces cold for the production of all qualities of steel, in the second instance the electric furnaces are reserved for refining high-class products. In fact, the controlling factor in the cost of production of electric steel is the price of the kilowatt. Hence when this is high, as with heat engines, it is reasonable for the preliminary treatment to be done by the open-hearth or other process.

It is pointed out that the various works in France have already been described; but among recent additions a five-ton Héroult furnace has been installed at the Saut du Tarn Works to replace crucible furnaces; Ugines has installed a complete electro-metallurgical plant with electric furnaces, rolling mills, forge and foundry, distinct from the old works; the Imphy furnaces have provided the material for M. Pourcel's investigations on the new steels; Unieux has adopted a new form of Keller furnace, consisting of a single cylindrical receptacle

with a spherically-vaulted cover through which pass four electrodes, two of each polarity.

The electric furnace is practically only a heat producer, as the only part of it affecting the reactions chemically is the lining, which is preferably basic; hence, provided distinctly acid slags are avoided, the whole sequence of metallurgical operations can be produced in the electric furnace. In all French works the operations of making steel are divided into two different categories, the first conducted under oxidising conditions, whilst in the second reducing influences obtain. As neither any ordinary atmosphere nor blown-in air are employed during the oxidising operations in the electrical furnace, red-short metal does not enter into consideration, and in almost all such works the highly calcareous slags of the basic furnaces are replaced by highly ferruginous ones. These have the advantage of melting and reacting at low temperatures, which is not only favourable to removal of phosphorus, etc., but also enables the deoxidation to be started at a desirably lower temperature; the solubility of iron oxide in the bath, it must be remembered, augments considerably with the temperature. The reducing operations follow immediately on the removal of the oxidising slags and are effected by the usual agents, but the products of the reaction must be either gaseous or insoluble in the bath; hence carbon is preferred in the arc furnaces and rich ferro-silicon in the induction furnaces. The reducing slags are not of the same character at all works, but the tendency is to have them as acid as the linings of the furnace permits. These slags are more fusible than the slags in basic steel works, and consequently require much less fluorspar. The reduction, being the result of the interaction between the slag and the bath, if continued long enough can effect the removal of the last traces of oxygen, and when this happens the elimination of sulphur follows; inasmuch as the sulphides pass into the slags, and in the presence of lime and carbon or silicon, give rise to calcium sulphide, which is insoluble in the bath. A notable feature of steels produced in the electric furnace is their low content in hydrogen and nitrogen; the elimination of the former is specially interesting, as it arises from the reaction of the calcium carbide, formed in the electric furnace, with the hydrogen, which then forms acetylene and passes away. The advantages of the electric furnace are summed up, and a future predicted for its extensive application.

EUTECTIC ALLOYS.

By Cecil H. Desch (University of Glasgow).

The mechanical properties of eutectic alloys are dependent on the mode in which the component crystals are interlocked. The microscopical examination of such alloys shows that they cannot be correctly described as parallel inter-crystallisations of the two components. In some eutectics neither constituent exhibits definite crystal outlines, whilst in others the crystalline arrangement is evidently due essentially to one of the constituents. This is well seen in alloys of copper and antimony, in which the antimony determines the crystalline arrangement. This conclusion has also been arrived at by Rosenhain and Tucker, from their elaborate study of the lead-tin alloys, in which the crystalline arrangement of the eutectic is determined by the tin, the B-solution forming a filling. It is not certain which property of a metal enables it to exert this directive force on the crystallisation of a eutectic. It would seem to be associated with the power possessed by some substances of forming crystal skeletons rather than small, isolated crystals. Thus in the alloys chiefly studied in the present paper free antimony is able to form long, fern-like growths, and in specimens containing an excess of antimony the eutectic structure is seen to have a definite orientation with respect to these crystals. The same is seen in the phosphor-coppers. The crystallites are not always terminated by plane faces, rounding due to surface tension at the time of solidifying being frequently seen. Thus in copper-silver alloys, or in copper containing oxygen, the small rod-like crystallites are rounded. The true nature of such a eutectic is seen on comparison with one in which the rods are straight and regular, as in nickel containing phosphide.

Owing to undercooling the eutectic structure may be reduced or absent, a thin belt of the second constituent being found to replace the laminated eutectic. The extent to which such undercooling may take place has been determined by Miers and his collaborators. The supersolubility curves and hypertectic points discovered by them have not yet been realised in the case of alloys, but are probably realisable.

Although the eutectic structure represents a stable phase-equilibrium from a chemical point of view, it is not physically a stable structure. The forces which bring about the growth of crystals continue to act after solidification is complete, and the larger masses of that constituent which has the greater power of orientation tend to attract the smaller. This is the cause of the well-known segregation of cementite in pearlitic (eutectoidal) steel. It is hindered only by the slowness of diffusion in solid solutions.

THE INDUSTRIAL APPLICATION OF METALLOGRAPHY.

By M. Louis Revillon (Paris).

The author points out that metallographic microscopy has definitely emerged from the domain of pure science. In the case of *bronzes* the metallographic examination of the polished section discloses the presence of blow-holes, and even the quantity of lead present can be judged by the extent of the little black masses, whilst by etching with ferric chloride the presence of the eutectic and certain copper components are disclosed, which are rendered still more evident by the use of soda and oxygenated water for etching. Tin components turn black when heated with soda or picrate of soda, whereas the silicon or phosphorus constituent retains its light colour.

Brasses, when examined metallographically, reveal their composition by the different appearance of the constituent solid solutions after treatment with an ammoniacal solution of copper or with ferric chloride; they yield a graduated series of appearances varying with the relative proportions of zinc and copper; moreover, the presence of impurities is indicated, and to a large extent the treatment they have received and the mechanical properties of brasses may be inferred. In fact, it is possible in the case of brasses containing more than 67 per cent. of copper to say whether it is simply cast, drawn, or annealed; to measure the size of the grains; and to gauge the extent of the hardening, or the degree of the annealing.

Steels show their characters, composition, and disclose the treatment they have undergone, when appropriately treated and examined metallographically, which is in fact the most rapid way of ascertaining their composition and properties.

Messrs. S. Owen and W. J. Jones, engineers and agents, Great George Street, Westminster, London, S.W., trading under the style of S. Owen & Company, have dissolved partnership.

A Foundry for Tramway Crossings.

The Tramways Department, of Manchester, having experienced difficulty in obtaining track crossings at short notice have faced this difficulty in an enterprising manner. The points for their special track work, being all standardised, are stocked at their depôt ready for use at a moment's notice, but the diversity of angle and curvature in the crossings precludes any stock of these being kept. They have, therefore, installed at their Hyde Road Depôt a small foundry, which enables them to manufacture iron-bound rail crossings with every expedition, and incidentally any special casting urgently required.

The plant (Fig. 1) is installed beneath a railway arch, which has been most conveniently adapted for this purpose and consists of two self-contained and entirely enclosed Morgan's patent tilting crucible

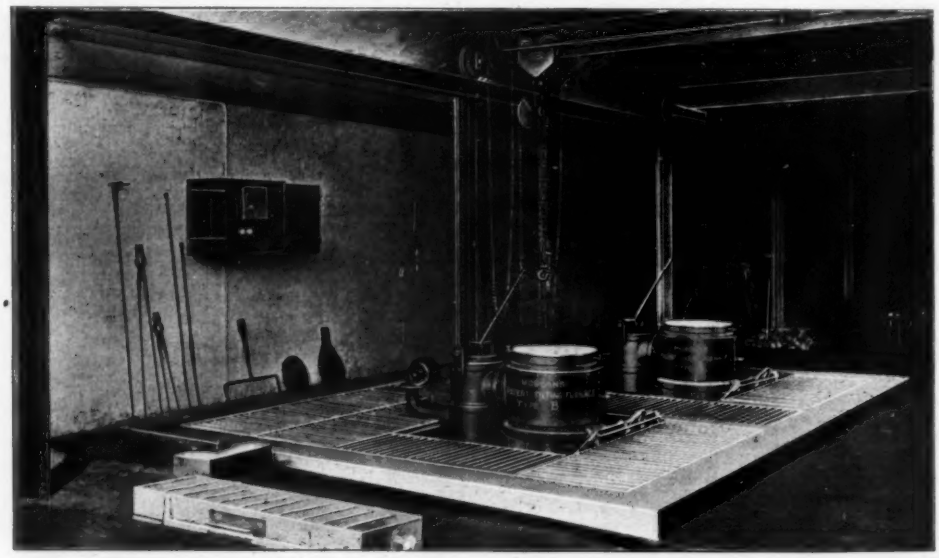


FIG. 1.—MANCHESTER CORPORATION FOUNDRY: VIEW OF THE MORGAN CRUCIBLE FURNACES.

furnaces, fixed in a pit in the foundry floor. Forced draught is obtained by Keith-Blackman fans mounted on the furnace frames, the exhaust fumes being carried away above the railway parapet. Whilst in operation there are neither flames or fumes perceptible, and the heat radiating from the furnaces is very slight.

The actual melting takes place in the crucible fitted into the central portion of the furnace, which contains also the fire surrounding the crucible. When the melting is completed the top portion is swung round (Fig. 2), and the central body containing the crucible and fire, lifted bodily out by the overhead travelling cranes, and conveyed to the moulds. The metal is then poured (Fig. 3) by means of the tilting gear direct from the crucible into the mould, and as the fire still surrounds the crucible the loss of heat is trifling. Cumbersome as this bulk may appear the gear attached is so effective that the metal can be poured into a 2-in. hole direct.

The capacity of each furnace is 600 lbs. of cast iron, making, with both in operation, 1,200 lbs. of metal available at one cast. The first run, starting cold, can be made in 3½ hours, the subsequent runs with about 2 hours between. The coke consumed gives about 2½ lbs. of metal per lb. of coke for the first run, and over 4 lbs. of metal per lb. of coke afterwards. The metal used consists of worn brake blocks, scrap, pole bases, etc., with a proportion of pig-iron to toughen the material.

The rails forming the crossing, having been cut and shaped, are bedded solid in the moulding floor, and accurately laid to template for the correct angle and curve, care being taken that contraction is allowed for; the mould is formed around the ends and the top box, with the core for the hardened steel plate, is fitted over. The whole is then weighted down and the cast iron poured around, taking from 700 to 800 lbs. of iron, according to the angle. The surplus metal is run into smaller casting of various sorts, for which there is always a large demand in connection with car fittings, etc.

The economy of this system of melting is demonstrated by the following figures taken at the official trial of one of the furnaces. The low fuel consumption and the rapid melting are points worthy of note: —

	Weight of Metal. lb.	Weight of Coke. lb.	Time taken to run down charge. h. m.	Average lb. metal melted per lb. fuel consumed.
1st heat	600	250 (includes lighting up).	3 35	2.4
2nd heat ...	600	151	2 5	3.97
3rd heat ...	600	141	2 0	4.26
4th heat ...	600	129	1 50	4.65
Total ...	2400	671	9 30	3.58*

* Mean average.

Nine months' experience in the working of the foundry has demonstrated its extreme utility and

economy, but its most important value is the facility offered for the manufacture of a crossing or other casting in a minimum of time; a complete crossing ready for laying could be manufactured in three working days—this including the making of templates, cutting rails, moulding, and casting—whilst any special casting could be prepared within 4 hours, or any longer time required for moulding.

Fig. 4 shows a few of the iron-bound crossings which have been manufactured.

The plant has been designed, and the construction carried out, by the staff of the Tramways Department, the furnaces being supplied by the Morgan Crucible Company, Limited, Battersea Works, London, S.W., and the overhead cranes by Messrs. Vaughan & Sons, Limited, Manchester.

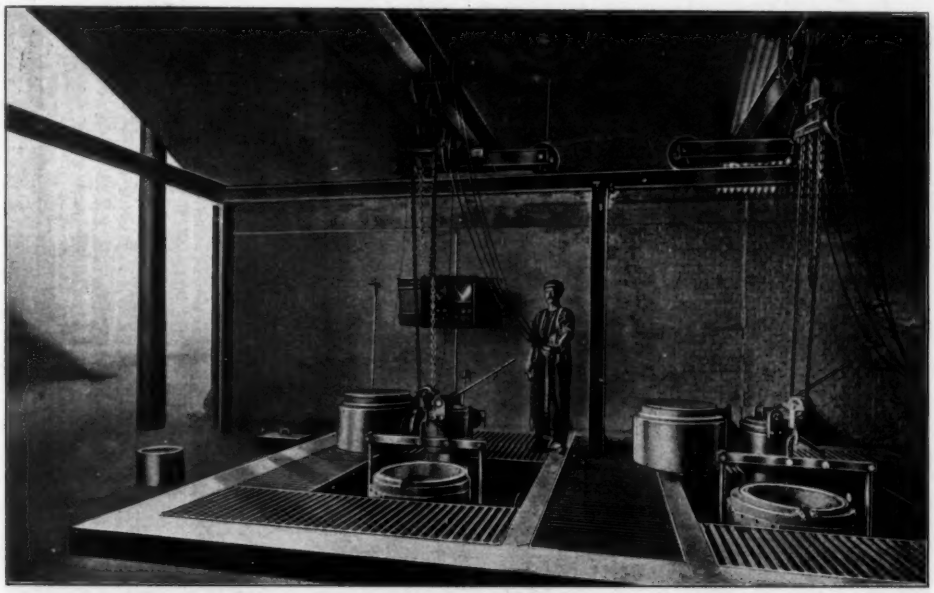


FIG. 2.—VIEW OF THE FURNACES, SHOWING THE TOPS REMOVED PREVIOUS TO POURING.

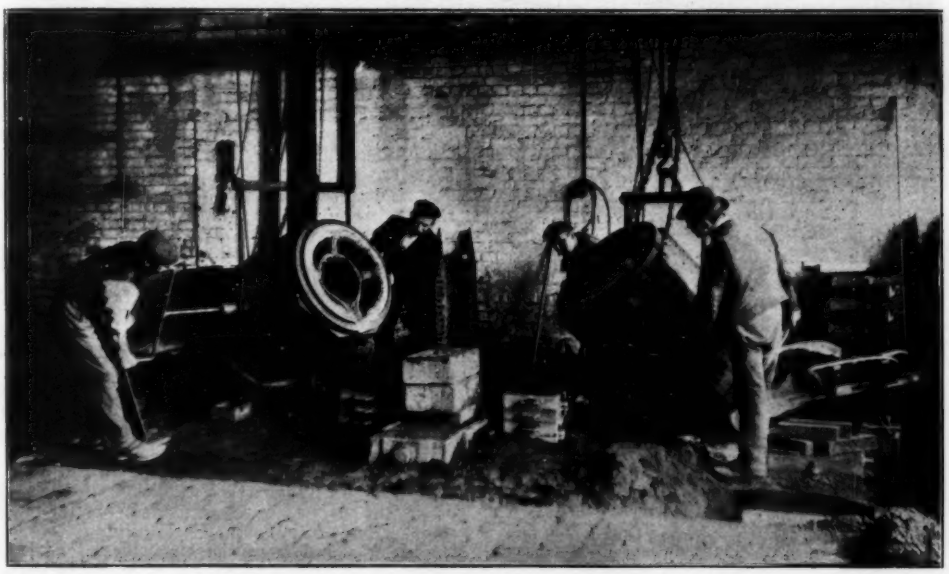


FIG. 3.—POURING FROM THE MORGAN CRUCIBLE FURNACES.

The Cost of Steel Making in Foundries.*

By Bradley Stoughton.

Acid Open-Hearth Process.

The cost of steel making by the acid open-hearth process is shown in Table I. In connection with this and the other tables it is to be observed that the price of raw materials is figured on the basis of a short ton of 2,000 lbs., and all prices in this paper are based on the current price of the materials in Pittsburg the first week of May, 1909.

It is not to be supposed that these figures will be accepted by every one as representative of their practice or anything like it, but the prices and weights of raw materials can be changed by any one to conform with his practice. Especially will the item of "heads, gates, etc.," depend largely upon the class of work made. No doubt there are some foundries in which the percentage of heads, gates, skulls, scrap, etc., is less than 33, while in others it will be above that figure. One has only to consider the difference in this respect between a foundry making steel rolls and one doing electrical work—notably castings for motors—to appreciate how great a difference will exist. I have adopted here 33 per cent. of scrap in the case of all processes to make this item comparative.

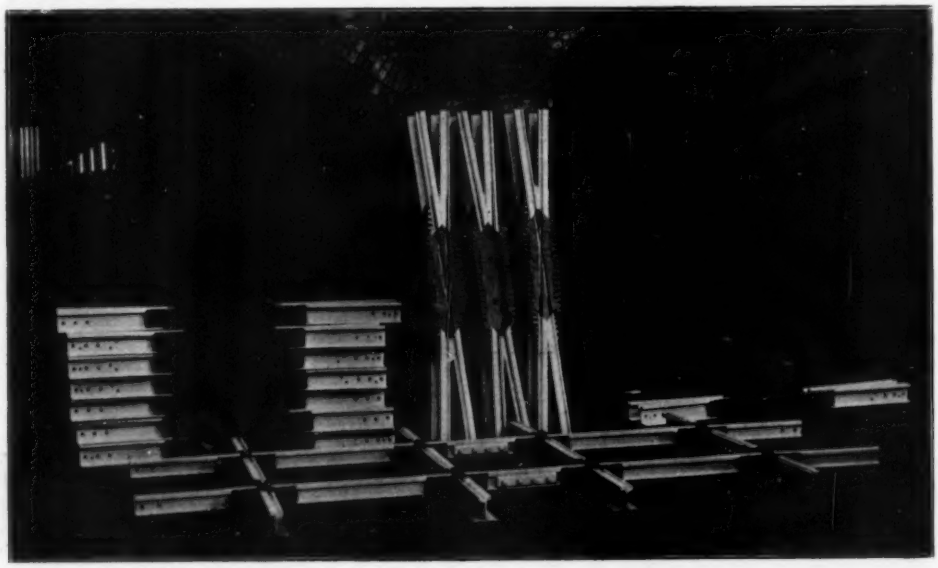


FIG. 4. TRAMWAY CROSSINGS CAST AT THE MANCHESTER CORPORATION FOUNDRY.

TABLE I.—*Acid Open-Hearth.*

	Price of raw materials per 2,000 lbs.	Per 2,000 lbs. of steel in ladle. Weight used	Per cent. used.	Cost.	Cost.
	s. d.	lbs.		s. d.	s. d.
Pig-iron	56 0	300	15	8 5	—
Heads, gates, &c ...	56 0	660	33	18 6	—
Foreign scrap	58 0	1,080	54	31 4	—
Defective castings* account bad metal...	200 0	20	1	2 0	—
Ferro-alloys	102 6	29	1	2 5	—
Total metal		2,089	104	62 8	62 8
Operating costs				22 0†	35 6†
Cost of steel in ladle				84 8	98 2
Cost of Steel in Castings.					
Cost of steel in ladle ÷ 65 per cent. ‡ = ...				130 0	151 0
Less credit for heads, &c., as scrap				18 6	18 6
Net cost of steel in castings				111 6	132 6

* The price given for defective castings is over and above their value as scrap. See the text following for further discussion of this charge.

† The charge of 22s. for operating costs is the figure for a 25-ton furnace and large tonnage; that of 35s. 6d. is for a small furnace and small production.

‡ Of the steel in the ladle, 65 per cent. goes into castings; 33 per cent goes into heads, gates, &c.; 2 per cent. is lost in spattering, &c.

* Paper read before the Cincinnati Convention of the American Foundrymen's Association, May, 1909.

The item "defective castings," chargeable against the furnace, as distinguished from those chargeable against bad moulding, will also vary greatly in different places, and it is probably impossible to estimate an average figure, either for the percentage of those made or for the price. The latter will depend partly on the average selling price of the castings and partly on the condition of the castings when the defects were discovered, as, for example, whether costs of cutting off heads and gates, cleaning, shipping to and from the customer, etc., should be included. In point of fact it is probable that there are not many foundries in which the defective castings chargeable against bad metal are differentiated from those chargeable against bad moulding, yet it is evident that the former only should be included in the cost of steel. Defective castings chargeable against moulding are included here in the item of heads, gates, etc.

The charge of 22s. for operating costs per ton is the practice with a 25-ton furnace operating at maximum capacity and charging raw materials by hand. For small furnaces, and furnaces operating at low capacity, this item will be materially larger. It is not to be supposed that the 22s. is a minimum figure, as, no doubt, some practice is better than this, and 35s. 6d. is not a maximum figure, as the cost of some furnaces is somewhat higher.

Converter Process.

The cost of steel making by the converter process is shown in Table II., where the same comments apply

TABLE II.—*Converter Process.*

	Price of raw materials per 2,000 lbs.	Per 2,000 lbs. of steel in ladle. Weight used.	Per cent. used.	Cost.	Cost.
	s. d.	lbs.		s. d.	s. d.
Pig-iron	56 0	300	15	8 6	—
Pig-iron	69 6	1,280	64	44 6	—
Heads, gates, &c. ...	56 0	660	33	18 6	—
Defective castings, account bad metal...	320 0*	20	1†	3 3†	—
Ferro-alloys	162 6	35	2	3 0	—
Total metal		2,295	115	77 9	77 9
Operating costs				14 0‡	22 0‡
Cost of steel in ladle				91 9	99 9
Cost of Steel in Castings.					
Cost of steel in ladle ÷ 65 per cent.				140 9	153 0
Less credit for heads, &c., as scrap				18 6	18 6
Net cost of steel in castings				122 3	134 6

* See footnote under acid open-hearth table.
† The percentage of defective castings in converter practice will actually be less than this, so that the cost is a little higher than just ce to average converter practice demands. In the absence of average figures we have charged it the same as acid open-hearth, with this verbal correction.
‡ Operating cost 14s. is for one 2-ton converter making 150 tons per week. The 22s. per ton is a 2-ton converter with small production.

as those made in connection with the acid open-hearth process.

The operating cost of 14s. per ton applies to the making of 150 tons of castings per week in one converter. It will appear very low to some practitioners, who have to pay a high price for fuel, etc., and whose tonnage is lower. A second figure of 22s. per ton is, therefore, shown to apply under such circumstances.

The waste of metal of only 15 per cent. shown in the foregoing table will also appear low to many whose practice is not as favourable as this, and therefore Table III. is given to illustrate the cost under such conditions.

TABLE III.—*Converter with Large Waste.*

	Price of raw materials per 2,000 lbs.	Per 2,000 lbs. of steel in ladle. Weight used	Per cent. used.	Cost.	Cost.
	s. d.	lbs.		s. d.	s. d.
Pig-iron	56 0	300	15	8 6	—
Pig-iron	69 6	1,360	68	47 3	—
Heads, gates, &c. ...	56 0	660	33	18 6	—
Defective castings, account bad metal ...	320 0	20	1	3 3	—
Ferro-alloys	162 6	38	2	3 0	—
Total metal		2,378	119	80 6	80 6
Operating costs				14 0	22 0
Cost of steel in ladle				94 6	102 6
Cost of Steel in Castings.					
Cost of steel in ladle ÷ 65 per cent.				145 6	157 9
Less credit for heads, &c., as scrap				18 6	18 6
Net cost of steel in castings				127 0	139 3

It will be observed that the converter is not in a position to compete on even terms with either the acid or basic open-hearth process, and must rely on a special grade of work for its field. This field, as is well-known, is the manufacture of steel for small castings, where the small converter now holds the predominant position. Since the electric process will doubtless first enter this same field, it may be well to consider anew the acid and basic open-hearth processes from this standpoint.

Basic Open-Hearth Process.

The cost of making steel for castings by the basic open-hearth process is shown in Table IV., and the

TABLE IV.—*Basic Open-Hearth.*

	Price of raw materials per 2,000 lbs.	Per 2,000 lbs. of steel in ladle. Weight used.	Per cent. used.	Cost.	Cost.
	s. d.	lbs.		s. d.	s. d.
Pig-iron	51 0	1,040	52	26 6	—
Heads, gates, &c. ...	56 0	660	33	18 6	—
Foreign scrap	44 6	350	17½	8 0	—
Defective castings* ...	200 0	40	2	4 0	—
Ferro-alloys	162 6	33	1½	2 9	—
Total metal		2,123	106	59 9	59 9
Operating costs				24 6†	38 3†
Cost of steel in ladle				84 3	98 0
Cost of Steel in Castings.					
Cost of steel in ladle ÷ 65 per cent.‡ = ...				129 0	150 0
Less credit for heads, &c., as scrap = ...				18 6	18 6
Net cost of steel in castings				110 6	131 6

* See footnote under the acid open-hearth table.
† See footnote under the acid open-hearth table.
‡ Of the steel in the ladle, 65 per cent. goes into castings; 33 per cent. goes into heads, gates, &c.; 2 per cent. is lost in spattering in pouring.

same comments made under the head of acid open-hearth steel will apply here.

The difference in costs between basic and acid open-hearth shown here is less than the experience of several would lead them to believe. The explanation of this is that the basic open-hearth process is in use generally in districts where low-phosphorus raw materials sell at a lower price as compared with high-phosphorus raw materials than is the case in the Pittsburg district, and also because the greater proportion of defective castings made in the basic process is not ordinarily included in figuring the cost of the steel. Furthermore, in the cost here given the basic process is under a disadvantage through having to use 33 per cent. of its own heads and gates, which command a higher price in the market than scrap suitable for the basic process would demand. This condition explains the common practice of operating both a basic and acid furnace in the same plant, enabling the acid furnace to use the scrap from both processes at a favourable figure and thus allowing a larger proportion of cheaper basic scrap to be purchased outside. This condition is exemplified in Table V., where the benefit of the combination to both processes is shown.

TABLE V.—*Acid Open-Hearth and Basic Open-Hearth (When together in One Plant).*

	Acid Open-hearth. Price of raw materials per 2,000 lbs.	Per 2,000 lbs. of steel in ladle. W'ght. used	Per ct. used	Cost	Basic Open-hearth. Price of raw materials.	Per 2,000 lbs. of steel in ladle. Wght. used.	Per ct. used.	Cost
	s. d.	lbs.		s. d.	s. d.	lbs.		s. d.
Pig-iron	56 0	300	15	8 6	51 0	1,010	52	26 6
Heads, gates, &c., from both furnaces ...	56 0	1,320	66	37 0	—	—	—	—
Foreign scrap ...	58 0	420	21	12 3	44 6	1,010	15½	22 6
Defective castings ...	200 0	20	1	2 0	200 0	40	2	4 0
Ferro-alloys ...	162 6	29	1	2 6	162 6	33	1½	2 9
Total metal ...		2,089	104	62 3		2,123	106	55 9
Operating costs				22 0				24 6
Cost of steel in ladle				84 3				80 3
Cost of Steel in Castings.								
Cost of steel in ladle ÷ 65 per cent.				129 0				123 3
Less credit for heads, &c., as scrap				18 6				18 6
Net cost of steel in castings				110 6				104 9

Acid and Basic Open-Hearth Processes making Small Castings.

The most important circumstance which keeps the open-hearth processes largely out of the field of making steel for small castings, and which often results in open-hearth foundries even sending their orders for small castings to foundries equipped with a converter or crucible process, is the large percentage of defective castings made by the open-hearth process when producing steel for small castings, say, for example, castings thin in section and under 100 lbs. in weight. In Tables VI. and VII. I have

TABLE VI.—*Acid Open-Hearth (Making Small Castings.)*

	Price of raw materials per 2,000 lbs.	Per 2,000 lbs. of steel in ladle. Weight used.	Per cent.	Cost.	Cost.
	s. d.	lbs.		s. d.	s. d.
Pig-iron	56 0	300	15	8 6	—
Heads, gates, &c. ...	56 0	660	33	18 6	—
Foreign scrap	58 0	980	49	28 6	—
Defective castings, account bad metal ...	200 0	120	6	12 0	—
Ferro-alloys	162 6	29	1	2 6	—
Total metal		2,089	104	70 0	70 0
Operating costs				22 0	35 6
Cost of steel in ladle				92 0	105 6
Cost of Steel in Castings.					
Cost of steel in ladle ÷ 65 per cent.*				141 0	161 9
Less credit for heads, &c., as scrap				18 6	18 6
Net cost of steel in castings				122 6	143 3

* Of the steel in the ladle, 65 per cent. goes into castings: 33 per cent. goes into heads, gates, &c.; 2 per cent. is lost in spattering during pouring. In making small castings the loss in pouring from a bottom poured ladle would be much larger than this, and the cost of steel in castings would be increased 4s. to 12s. per ton, but data are lacking for exact estimates.

TABLE VII.—*Basic Open-Hearth (Making Small Castings).*

	Price of raw materials per 2,000 lbs.	Per 2,000 lbs. of steel in ladle. Weight used.	Per cent. used.	Cost.	Cost.
	s. d.	lbs.		s. d.	s. d.
Pig-iron	51 0	1,010	52	26 6	—
Heads, gates, &c. ...	56 0	660	33	18 6	—
Foreign scrap ...	44 6	190	9½	4 3	—
Defective castings ...	200 0	200	10	20 0	—
Ferro-alloys	162 6	33	1½	2 9	—
Total metal		2.123	106	72 0	72 0
Operating costs				24 6	38 8
Cost of steel in ladle				96 6	110 3
Cost of Steel in Castings.					
Cost of steel in ladle ÷ 65 per cent.				148 3	169 6
Less credit for heads, &c., as scrap				18 6	18 6
Net cost of steel in castings				129 9	151 0

[Where the allowance for defective castings is 15 per cent., or 30s., and the cost of foreign scrap (17½ per cent.) is 8s., the above costs of steel in castings become 142s., and 163s., on the respective operating costs given.]

shown the costs of steel in the acid and basic open-hearth processes when the percentage of defective castings chargeable to bad metal is large.

Crucible Process.

Wherever the electric steel-making process has come into use it has been the crucible steel process that has usually been supplanted, with one or two notable exceptions. Therefore, it is the crucible steel foundries that view the electric process with the most interest. One important consideration in this connection is, however, the cost of installation, for this will be at least 10 times as much in the case of the electric process as in the case of the crucible process.

TABLE VIII.—*Crucible Process.*

	Price of raw materials per 2,000 lbs.	Per 2,000 lbs. of steel in ladle. Weight used.	Per cent. used.	Cost.
	s. d.	lbs.		s. d.
Foreign steel scrap	58 0	1,330	66½	38 6
Heads, gates, &c.	56 0	660	33	18 6
Defective castings	500 0	10	½	2 7
Ferro-alloys	162 6	12	½	1 0
Total metal		2,012	100½	60 7
Operating costs				140 0
Cost of steel in ladle				200 7
Cost of Steel in Castings.				
Cost of steel in ladle ÷ 66 per cent.*				304 0
Less credit for heads, &c., as scrap				18 6
Net cost of steel in castings				285 6

* Of the steel in the ladle, 66 per cent. goes into castings; 33 per cent. goes into heads, gates, &c.; 1 per cent. is lost in pouring.

[When melting wrought iron, which is common practice when making the higher grades of tool steel, &c., the cost is 332s. for a 66 per cent. yield of castings, 1,360 lbs. of wrought-iron casting (69s. 6d.) being used instead of foreign steel scrap, as above.

Electric Steel Process.

The electric steel-making process has two advantages over the crucible process: First, it can use the cheapest form of steel scrap available in the market,

TABLE IX.—*Electric Process.*

	Price of raw materials per 2,000 lbs.	Per 2,000 lbs. of steel in ladle. Weight used	Per cent. used.	Cost.
	s. d.	lbs.		s. d.
Steel scrap	38 0	1,330	66½	25 4
Heads, gates &c.	56 0	660	33	18 6
Defective castings	500 0	10	½	2 7
Ferro-alloys	162 6	12	½	1 0
Total metal		2 012	100½	47 5

	Cost of steel in ladle.	In casting.
	s. d.	s. d.
Electric power at ½d. per kilowatt hour ...	115 3	156 0
Electric power at 1d per kilowatt-hour ...	152 0	211 6
Electric power at 1½d. per kilowatt-hour ...	188 6	267 0
Electric power at 2d. per kilowatt-hour ...	225 0	322 6
Electric power at 2½d. per kilowatt-hour ...	261 9	378 0

and, second, it can turn out the highest grade of steel made, the electric furnace surpassing all others in its control over the phosphorus, the sulphur, the temperature and the gases dissolved in the metal. The cost of making steel by the electric process is shown in Table IX., which is based upon figures furnished by the makers of some of the important furnaces, and from published results of actual steel melting operations on a commercial scale.

It was announced some few months ago that a change of proprietorship had occurred in the business of the Newall Engineering Company, and that the works and offices would later be transferred to Blackhorse Lane, Walthamstow, London, E. This removal is now completed, the new factory fully equipped and running, and all arrangements have been made for continuing, upon improved lines, the production of those articles associated with the Newall name.

A NEW company has been formed entitled the Cowper-Coles Engineering Company, Limited, with a working capital of £40,000, and offices at Grosvenor Mansions, 82, Victoria Street, S.W. The company has been registered as a private company, and no issue will be made to the public. The objects of the company are to develop the business of Sherard Cowper-Coles & Company, Limited, and to carry on the work of electro-metallurgists and chemical engineers.

Notes on Brass Melting.*

By Charles T. Bragg.

The making of alloys of standard composition seems to be drawing well-deserved attention. There is a considerable degree of uncertainty in many brass foundries as to the actual composition of the alloys made in those foundries. The proportions of prime metals used to make an alloy are often weighed with great care, and completely neglected thereafter. No consideration is given to losses of the original material, and no compensation made for losses while the scrap from that original material is being sent back through the re-melting cycle, or at least not in a scientific way.

The gradually increasing demand for alloys of certain definite physical characteristics is bringing about the development of a great number of metals, about which too little is known. Undoubtedly, in many cases, if instead of finding a new alloy to suit each new engineering condition that arises, we knew something of those we already have, we would find that another was not needed. In order to know our alloys in all their phases, and in order to be able to keep their constituents always present in a constant proportion, the fewer we have the better. In order to completely standardise our alloys and keep them under control, unquestionably the fewer we have, the easier will be the subsequent labour and the less intricate the system necessary.

Several factors are important to the successful standardisation of alloys. Good original alloys, complete knowledge of materials to be used in their manufacture, control of the furnaces in which they are made, knowledge of the changes and causes of the changes taking place in those furnaces, and complete knowledge of the composition of the resulting alloy, are the chief ones to consider. The choosing of suitable alloys is, of course, largely a matter of personal decision, but that decision is often influenced by factors unknown to the one making such decisions. In other words, in experimenting to find the most suitable alloy for a class of work, absolute knowledge of the quality of the materials used and results attained is essential. For this knowledge we must turn to the science of chemistry. It is not so much a question of whether we have produced what we want, as it is whether we have complete data on what we have produced, and whether we can repeat the production of that article. Let us say, for example, that we are developing an aluminium brass, and that copper, zinc, and aluminium have proved themselves the elements necessary. After repeated trials, using various proportions of these elements, we fail to get the desired physical characteristics. All conditions are equal, the analysis of the copper and aluminium show them to be pure, but the zinc contains iron, lead and cadmium. Using the same grade copper and aluminium, but a zinc free from impurities, we find ourselves able to produce aluminium brass to our satisfaction. We have begun an important thing, that of using articles about which we are thoroughly informed, and have cleared the road to the reproduction of the alloy in question, without difficulty, at least, from the standpoint of the prime materials to be used. An analysis of the metal produced will show what our real alloy is, and what it is that we are trying to make. That is, if the metal as it leaves the furnace is the composition desired, then the material that goes into the furnace is only important in that it shows what changes have taken place, and what compensation must be made for those changes, if that metal is ever to be made from its own scrap, gates, sprues, etc.

Considering now an alloy of ordinary constituents, variations of composition may be assigned to several causes, such as oxidation or volatilisation of one constituent to a larger degree than others present, loss by the same means of two of three constituents in varying proportions, or loss of one constituent by its reducing action on the oxides of another, as the loss of zinc due to its reduction of copper oxide, etc. In a forced draft furnace, other agencies have considerable bearing on the change of composition, chief of which is the action of gases, both unburned and products of combustion. The action of these gases, such as nitrogen, carbon monoxide, carbon dioxide, sulphur dioxide, etc., on brass at high temperatures, has been but imperfectly studied, although some of their general properties in other connections are well known. In a furnace which exposes an alloy to all these influences, certainly the best results are not possible, and the only road left open is to overcome the natural defects of the furnace by outside means.

Undoubtedly the greatest cause of variations in composition is due to oxidation and volatilisation. We will consider the loss of zinc in detail, inasmuch as it is both easily volatilised and oxidised. It is easily understood that at 718 degrees F. if exposed to air, zinc then in its melted condition begins to oxidise. 1,652 degrees F., the temperature at which zinc volatilises, is easily attained in brass melting. If sufficient time is given at 1,652 degrees F., or the temperature raised very high above this, in a short time all the zinc will volatilise. We are considering now that the zinc has been melted alone. When melted in brass it behaves, as far as we know, as when melted alone. That may or may not be true, inasmuch as any definite chemical compounds formed between zinc and other constituents present, may have considerable influence and doubtless do. The quantity of metal in a furnace has a certain influence over the time which must elapse to bring it to a required temperature. Therefore, since the melting point of the brass is above that of the zinc, zinc should begin to oxidise as soon as its melting point is passed. This, again, is variable, due to the fact that the contained zinc cannot be attacked by oxygen until the brass itself begins to melt, as it is not exposed, and due also to the different proportions in the alloy in which the zinc may exist. Taking the other constituents of brass or bronze into consideration, they might be handled in much the same way, depending, of course, on what they are. It would seem that a fixed length of time for a given quantity of a given metal with a fixed oil or gas flow and a fixed air pressure would be all that is necessary to make a brass of given constituents leave the furnace each time practically of the same composition. As heats of various sizes of various compositions for different classes of work are usually made by most foundries, it is evident that any such procedure would involve considerable difficulty. However, it would be comparatively easy to establish a temperature at which these various compositions should be removed from the furnace, and at some future time this may be possible. When it is possible to equip a brass-melting furnace with a pyrometer

* Abstract of a Paper read before the American Brass Founders' Association, May, 1909

which will, at all times, tell the temperature of the contained materials, the road to standardising alloys and stopping moulding troubles of many kinds will be clearer. Measuring temperatures in the crucible serves many good purposes, but does not eliminate the expense of varied compositions, nor does it eliminate the expense of furnace losses. Every composition has a definite melting point and a definite casting temperature, and the determination of just what these points are can be done only with a pyrometer. It is easily seen that if a brass or bronze of any composition be brought to a certain temperature in a definite length of time, its original and melted compositions could be made very nearly constant. It is worthy of note that very little attempt has been made, as far as the writer knows, at least, to bring this about.

We have seen that considerable variation is possibly due to many causes and must admit that it is very difficult to overcome many of these with present means. In spite of all this, it is still possible to keep the compositions of our alloys very nearly standard, if certain conditions are kept in mind. We have said before that if we know the purity of our virgin materials, and find the alloy which, when made from certain proportions of these materials, gives us the alloy with the properties and cost desired, we should endeavour to produce that composition constantly. There are two ways of doing this. First, the total loss of given original constituents in the furnace may be determined, and an analysis of the resulting material obtained, from which calculations back to the original composition may be made. Second, the analysis may be made of the resulting material and calculation made back to the original composition without knowing the total loss. In order to use the first method, the total loss in the furnace may be obtained as follows:—Weigh the virgin metals in the proportions before found to produce the alloy needed. Place in the furnace and melt, bringing the alloy to the necessary temperature for pouring the castings for which the alloy is intended. Observe the temperature attained and the time elapsed during melting, and when repeating the experiment, which must be done several times to obtain a fair average, endeavour to have the time elapsed and temperature attained nearly the same as before. This is assuming that the oil or gas, and air pressures (in furnaces using them) are kept constant. Weigh the metals in the crucibles after melting. The weight of the metal after melting, plus the metal in the slag, subtracted from the weight before melting, will give the loss for the particular furnace in use under the particular conditions mentioned. After establishing the total loss, repeated analyses of the product will show the average change in composition from the original proportions put into the furnace. This average of results should be considered as the composition of the alloy it is desired to produce. Now when the scrap, gates, sprues, runners, etc., from the alloy produced are returned to the metal depository, they should be kept distinctly separate from that of any other alloy, and when again issued to the furnace, should have added the metals lost during the former melting. The amount to be added may be calculated in the following way:—Take 100 lbs. as the unit weight of the original alloy. Subtract from that the percentage in pounds total loss established for that alloy. From the resulting figure, using the average analysis of the produced alloy, calculate the actual weight in pounds of each constituent present in the produced alloy, and subtract the result from the number of pounds of each corresponding constituent in 100 lbs. of the original alloy. The difference is the weight of each constituent lost per 100 lbs. of metal melted. That is, 100 lbs. minus the total loss per 100 lbs. in lbs., plus the metals "burned out," should be the metals re-issued to the furnace. Let us say, for example, that the loss on original materials was 5 per cent., then 95 lbs. of gates, sprues, etc., plus the amount of copper, zinc, lead, tin, etc., lost, in total 100 lbs., would be the proper amounts to issue to the furnaces. In arriving at the quantities of each constituent lost, the reason for the apparent gain in some slightly volatile metals such as copper, will be easily seen. The scheme as outlined above is open to the objection that the means of determining the total furnace loss is not to be compared for accuracy with the chemical laboratory process which determines the ratio of the constituents, although that depends, of course, on just how carefully both are carried out. In using this scheme, it must not be supposed that the losses for one alloy can be calculated to show the losses for others. The reason for this has been shown before.

In order to use the second method, the analysis of the produced alloy may be considered to represent the proportions of elements present per 100 lbs. of metal produced. Then 100 lbs. of scrap may be reverted to the original composition by adding 100 lbs. of prime metal in the proportions necessary to either increase or decrease the various constituents. This is open to the objection that for each unit weight of scrap issued, an equal amount of new metal must be used. This does not use the scrap on hand rapidly, and too rapidly reduces the virgin material on hand. This may be avoided by adding to 100 lbs. of scrap, the materials lost in largest proportions, in quantity sufficient to reduce those present in largest proportions, to the desired amounts. As this involves merely a problem in arithmetical proportion, it is easily worked out, and presents the best practical working method for ordinary alloys, of using the scrap produced. This introduces an error in the rebuilding scheme, since scrap made from scrap which was made from new material, must be considered to be of the composition of scrap made from new materials. However, over a period of time, this discrepancy corrects itself as the materials go back through the remelting cycle.

In using turnings from one's own alloys or scrap purchased outside, it is largely impractical to determine furnace losses for each case, and inasmuch as it is likely to be of variable composition from lot to lot, it is not practical to determine it for certain cases and calculate from that basis for others. In the case of turnings from one's own alloys, it is likely to be difficult to keep the turnings of one alloy from being contaminated with turnings from others. In addition, since the particles are small and more exposed to oxygen and heat, the loss is not to be considered as anything like that of the same alloy when made from either new or scrap materials. In general, if a sample of turnings is melted under the conditions that the alloy in which they are to be used is melted, and then analysed, they may be calculated into the alloy for which they are intended, using the alloy to be produced as the basis for calculation, as their loss has been already considered in the analysis.

MR. ANDREW TURNBULL, accountant, Kilmarnock, the liquidator of Thomas M'Culloch & Company, Limited, Grange Foundry, Kilmarnock, has presented a note to Lord Johnston in the Court of Session at Edinburgh, craving the Court *inter alia* to fix a date on or before which the creditors of the Company are to prove their debts, or be excluded from the benefit of any distribution of assets which may be made before such debts are proved. Creditors are accordingly required to lodge their claims with the liquidator on or before July 15.

The Electric Furnace and Electrical Process of Steelmaking.*

With Particular Reference to the Rochling-Rodenhauser Furnace.

(By W. Rodenhauser, Saarbrucken).

Electrically refined steel and the various furnaces for producing it, have been much discussed in industrial centres during the past few years. If I venture, in spite of this, to present a consideration of the comparative merits of the methods of refining steel electrically, and of the furnaces in which this is done—with special reference to the Röchling-Rodenhauser furnace—it is because a renewed consideration of the subject appears to be justified and demanded by the industry; since, though electric steel refining progressed slowly at first, it is now advancing with rapid strides, and is being readily taken up by the entire industry, and, in spite of the numerous publications concerning the operation of various systems, there is still a good deal that is obscure.

The following will give a summary of the types of furnaces which are available at the present time. All those furnaces which have got no further than being patented, and those which have been tested but have found no further application, may be passed over. The following only remain to be considered: The Stassano, Héroult, and Girod furnaces, on the one hand; and the Kjellin, Frick, and Röchling-Rodenhauser furnaces on the other. The furnaces which are enumerated above can be divided into two entirely distinct groups:—(1) Electric arc furnaces: (2) furnaces in which the arc is avoided. The main differences between the two groups are carefully considered in what follows. After Werner Siemens constructed arc furnaces in 1878-79, which closely resembled the Girod furnace, Stassano, in 1898, built the first arc furnace which was applicable to the iron industry.

It is well known that two or three carbon electrodes are employed in the Stassano furnace, and these are brought into the furnace from the side and dip down slightly from the horizontal, and one or more arcs are formed in the middle of a nearly circular hearth (see Fig. 1). We thus have a furnace which is heated by the heat radiated from the arcs. While the heat of the arcs is chiefly directed downwards, yet, as mentioned by Osann in "Stahl und Eisen" in 1908, a considerable quantity goes to heat the dome-shaped roof of the furnace.

A critical weakness of the Stassano furnace compared with other arc furnaces is that heat losses cannot be avoided, in spite of careful exclusion of air, on account of the doors being opened for inserting slag-forming materials, and for taking test-samples, etc. In addition, the roof can only stand the high temperature of the furnace for a short time, although it is composed of expensive magnesite; and a renewal occupies a considerable time, and the cost of renewals is heavy.

It must also be remembered that the electrodes project almost horizontally into the furnace, and so are more easily broken than if they were vertical, and that the entire furnace is arranged so that it can be rotated in order to mix the metal, and thus ensure homogeneity in the product. It seems scarcely probable, therefore, that this furnace will find extensive application except for small charges—up to a ton, for instance.

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In 1900, two years after Stassano, Héroult applied for the patent of his furnace, which is the best known arc furnace at present. In the Héroult furnace the arc is not formed between the two carbons, as in the Stassano furnace, but between the carbons and the bath of metal, so that the current which passes

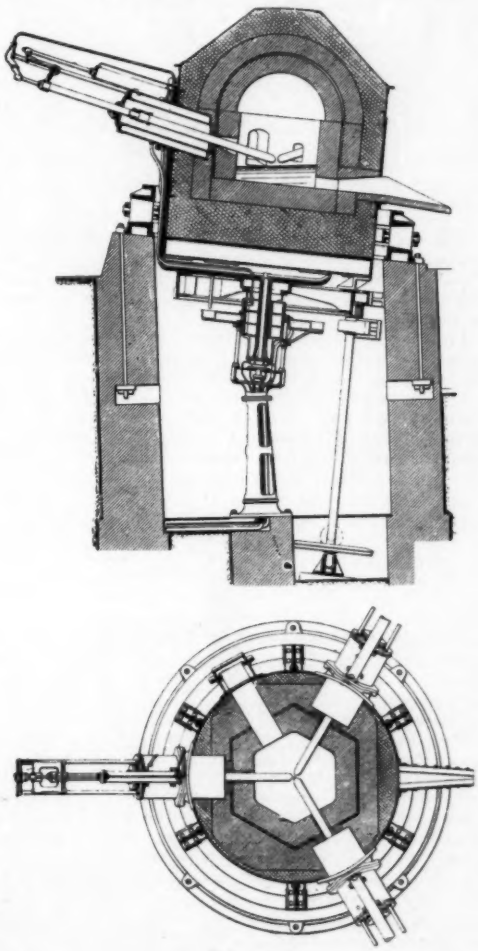


FIG. 1.

through the carbons also passes through part of the metal (see Fig. 2).

The construction of this furnace offers several advantages over the Stassano furnace. As the carbons are arranged vertically there is less chance of heating the roof, which is movable. The furnace does not need to be rotated, and so is more simple in construction. In common with all arc furnaces, the question of main-

tenance of the roof is the weak point, as this needs to be replaced every fourteen days.

The third arc furnace to be mentioned is the Girod furnace, in which one electrode is a suspended carbon, and the other electrode is made of iron, placed at the bottom of the furnace and water cooled (see Fig. 3). This furnace presents the advantage over the Héroult furnace that the demand for energy is more constant, so the electric generators are therefore working under better conditions.

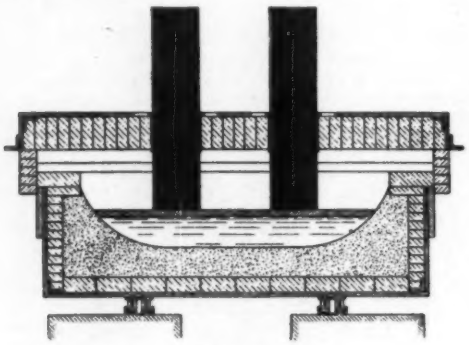


FIG. 2.

The Girod furnace closely resembles the Héroult furnace in its construction and method of working, the chief difference being that the Héroult furnace is oblong in shape, while the Girod frunace is square or round.

In all arc furnaces the place where the carbons pass through the walls must be thoroughly cooled, for the following reasons: (1) Without this thorough cooling the carbons will become very hot and oxidise rapidly where the air has access to them. (2) If the cooling arrangements are omitted it is difficult to prevent the carbons rubbing on the surrounding masonry where they enter the furnace, causing small currents to

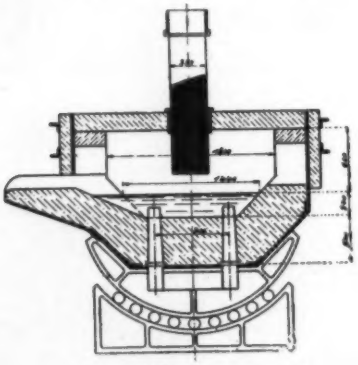


FIG. 3.

escape from one electrode to the other. This applies particularly to the Héroult furnace.

It may be pointed out that the provision of openings in the furnace roof, which is exposed to great heat, is a drawback, as the artificial cooling required at these apertures causes a great variation of temperature in the roof, which does not increase its durability. Apart from this, the water-cooling of these apertures involves a fairly considerable loss of heat, and consequent unavoidable waste of electric power, which costs money; it is accentuated by the fact that carbon, having a high electrical conductivity, is also a good conductor of heat.

Reference may now be made to the differences between the three furnaces which have been described, which appear to be more essential at first sight than is actually the case. It has been seen that in the Stassano furnace the heating of the bath takes place entirely by radiation from the arc; while in the Héroult furnace the method of heating is quite similar, but with the advantage that the arcs are formed against the bath.

In the Girod furnace the suspended carbon electrode acts in the same way as the carbon electrodes in the Héroult furnace. The difference between the Héroult and the Girod furnace consists in the current leaving the latter furnace by a water-cooled iron electrode in the bottom of the furnace instead of by a second suspended electrode. It appears doubtful if

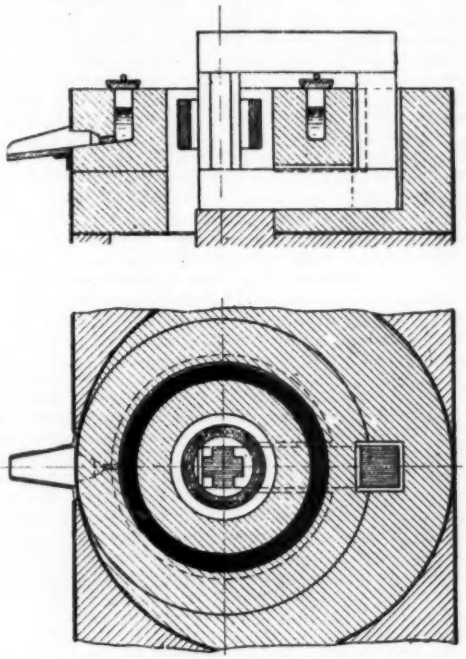


FIG. 4.

this arrangement presents any advantage from the metallurgist's point of view, for it is evident that there will be a gradual increase in temperature from the water-cooled electrode to the high temperature of the active bath of metal, and that the metal, which is solid near the electrode, becomes first pasty and then liquid farther away from it. If this evil does not appear fatal from a metallurgical standpoint, it must be remembered that energy is lost through cooling the furnace bottom, and this contributes to the cost of producing steel.

Girod, in using water-cooled electrodes in spite of these disadvantages, combines the advantages of the resistance furnace with those of the arc furnace. He apparently starts with the conviction that the action of the arc is not sufficient for heating a bath of steel, since the arc only affects the surface of the bath, so that with a deep bath and without sufficient circulation there can be very objectionable differences of temperature between different parts of the bath of metal. It can easily be seen that this can take place in a simple arc furnace, from the fact that the Stas-

sano furnace is arranged to rotate so as to thoroughly mix the metal. On this account Girod employs resistance heating as well as arc heating, in order to cause the electric current to flow through the bath to the bottom.

In a 2-ton Girod furnace the circular carbon electrode is 350 millimetres diameter (962.11 square centimetres area), while the average section of the bath is 1,200 millimetres by 1,200 millimetres, or 14,400 square centimetres. The depth of the bath is 240 millimetres and the length of the electrode 1,500 millimetres. From these figures we can calculate the proportion of energy expended in the carbon electrode and in the bath respectively, without taking account of that accounted for by the arc. Assuming that the temperature of the bath is 1,800 degrees C., and that of the electrodes is 1,000 degrees C. through their length, we get—

Resistance of the carbon electrode ...	779×10^{-6} ohms.
Resistance of the bath...	208×10^{-9} ohms.

In this furnace, therefore, the resistance of the carbon electrode is 3,800 times that of the bath of metal, so that 3,800 times more electrical energy is converted into heat in the carbon electrode than in the bath itself. If the current in the bath of metal, therefore, produces any considerable amount of the total heat of the furnace, either there is a great loss of energy in the carbon electrode, or the electrode must have a cross-sectional area of a size larger than is practicable.

The view that the passage of the current through the bath of metal has any great influence on the heat produced in a present-day arc furnace must be abandoned, and in these furnaces the heating must be entirely ascribed to the very localised effect of the arc. In spite of this, however, the passage of the current through the carbon electrode causes a considerable loss of energy.

These remarks about the Girod furnace apply also to the Héroult furnace, for though the current in this latter furnace is only half as large as required for the Girod furnace, yet in the latter case the current has to pass through two carbon electrodes instead of one, so that the results which have been calculated for the Girod furnace apply also to the Héroult furnace.

The conclusions respecting the operation of the arc furnace may be summarised as follows:—(1) The temperature of the charge cannot be appreciably increased by resistance heating. (2) The charge is almost entirely heated by the arc, and the heating is very much localised. (3) The passage of the current through the carbon electrodes gives rise to considerable loss of energy, due both to the comparatively high resistance of the carbon and to the water circulation for cooling the apertures where the carbons enter the furnace. This loss of energy is about 10 per cent. The cost of maintenance of the carbon electrodes is also considerable.

Induction Furnaces.

Attention may now be directed to induction furnaces; that is to say, furnaces in which the bath of metal is heated by inducing a current in it.

Suppose an alternating current is passed through a coil of copper wire called the primary, and another coil be suitably placed near it, then a secondary current will be induced in this coil, without the two coils of wire being in any way connected together. This property of an alternating electric current by which it can induce a secondary current enables a comparatively small current in the primary winding to induce a very large current in the secondary winding with a very small loss of power, the currents being inversely proportional to the number of turns in the respective windings. This principle of induction enables as large a current as may be required to be produced in an ideal manner, and Ferranti utilised this principle in the first instance by inducing currents in the body to be heated, and paved the way for all the modern electric furnaces. He obtained a British patent for his invention in 1887, which was constructed too much from the electrician's point of view, and has not attained practical importance.

This describes an induction furnace having the principal points of the Kjellin furnaces (see Fig. 4). In this furnace the primary winding is placed within a cylinder made of refractory material, and either cooled by water circulation or forced draft; the annular hearth surrounds this cylinder. This annular hearth contains the metal, which is an electrical conductor and acts as a single turn secondary winding. If a current is passed through the primary winding an exceptionally large current is induced in the metal in the hearth, which heats the metal, practically the total amount of electrical energy being converted into heat.

The construction of the Frick furnace, which has also attained some practical importance, is very similar to that of the Kjellin furnace. The principal difference between the Frick and the Kjellin furnaces is that in the former the primary windings are placed above and below the annular hearth instead of within it. The heat is produced in exactly the same way in both furnaces. In these furnaces the grooved annular hearth is the characteristic feature. These furnaces have no side doors, and the operations are watched and regulated by lifting off the covers of the grooved annular hearth section by section. The peculiar shape of the hearth naturally prevents the removal or changing of the slag, and so it should be pointed out that these furnaces are only adapted to conditions where comparatively pure materials are to be melted or alloyed.

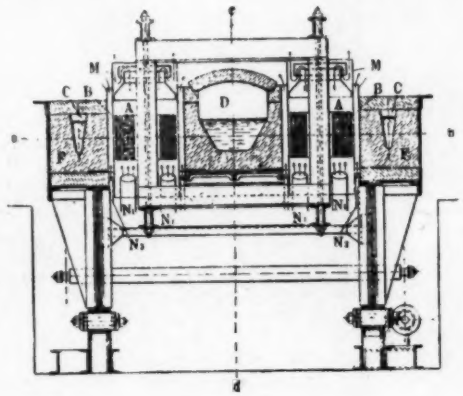


FIG. 5.

The Röchling-Rodenhauser furnace, which has been patented since 1906, has a hearth a very different shape from the induction furnaces previously described. This furnace is constructed for single-phase and for three-phase current, having two grooves in which metal is melted in the first case, and three in the second (see Fig. 5). In both cases these two or three grooves or heating channels, each of which corresponds to the annular hearth of one of the above-mentioned induction furnaces, open into a distinct open-hearth, the working chamber where all the metallurgical operations take place, while the grooves, which have a comparatively small cross section, form the secondary circuits in which the currents which heat the metal are induced.

Thus there is a working chamber surrounded by the transformer which closely resembles the hearth of an

arc furnace. Two lateral doors are provided in a single-phase furnace, and three in a three-phase furnace, which enable the hearth to be observed. As the furnace is so constructed that it can be tilted, one of the doors is provided with a spout for pouring the charge, while the furnace may be charged, or slag-forming material or additions may be thrown in through either of the doors. As the doors are not much above the level of the top of the bath, the slag can be as easily removed in the Röchling-Rodenhauser furnace as in an arc furnace, which is not the case with the other induction furnaces previously described, so that the Röchling-Rodenhauser furnace is very well suited for refining processes.

As access to the working hearth can easily be obtained through the doors in this furnace, the covers of the heating channels and the central hearth remain in position as long as the furnace is in operation. This enables any loss of heat to be kept as small as possible.

This central hearth D, of the Röchling-Rodenhauser furnace, in which the metallurgical operations are carried out, is very similar in form to the hearth of an open-hearth furnace, constituting one of the chief departures from the older electric furnaces, and this construction offers considerable advantages from the electrical standpoint.

In the older furnaces the current in the primary only serves to induce a secondary current in the annular hearth, but in the Röchling-Rodenhauser furnace a distinct secondary winding is provided in which a secondary current is induced by the primary current, and these windings are connected to cast-steel terminal plates which are embedded in the refractory material of the furnace. This refractory material becomes an electrical conductor at the higher temperatures and this enables an additional electric circuit to be formed, so that the currents induced in the secondary winding pass through the terminal plates to the central hearth and through the bath of metal, heating the bath still further. The conditions in which current is passed through the bath in this furnace are very different from those in which current is passed through in the arc furnaces described in the earlier part of this paper. There is very little wastage of the part of the refractory material which serves as the electrical conductor, and it has even been found that these parts last the longest of any part of the furnace lining.

There is no necessity for changing the terminal plates, and the heavy charges for replacement of electrodes which are incurred with all types of arc furnaces are avoided. In addition, there is no possibility of the bath of metal taking up impurities from the electrodes, as the current-carrying parts in contact with the metal are composed of the same material as the rest of the lining, while with the arc furnaces there is always the danger of the bath taking up impurities from the electrodes. Finally, the very considerable losses of energy which take place due to the passage of current through the carbon rods which form the electrodes are avoided; for, on the one hand, the terminals are thin plates which present a very large area instead of the rods, so that the electrical resistance is greatly reduced, and on the other hand, the terminals are close to the bath of metal, so that the heat produced in them is available for heating the bath. The heating action of the secondary circuit which supplies current direct to the bath is only one of its functions; the other, which is not the least important, is the improvement of the electrical conditions.

FIG. 6.—8-TON SINGLE-PHASE RÖCHLING-RODENHAUSER FURNACE.

How does the capital cost for the various types of electric furnaces compare? It is of interest to investigate this question further, as the capital cost can exercise a very considerable influence on the working costs of an electric furnace plant.

In considering the cheapness of operating an electric furnace plant, the system of current supply required by the furnace must be determined. Since none of the foregoing electric furnaces can, as a rule, usually work on a direct-current system, it is a question of single-phase or three-phase alternating current; and if there is a choice between the two, it is better to decide on three-phase, as the capital cost of three-phase electric generators is about 25 per cent. less than that of single-phase generators.

The question of periodicity should not have much influence on the choice of a furnace, as the furnace which has attained the greatest prominence works

with the usual periodicities of from 25 to 50 cycles per second. As far as I know, the only successful three-phase furnaces are the Stassano and the Röchling-Rodenhauser, as the Girod and Héroult furnaces require single-phase current. In the case of the Girod furnace all the electrodes above the bath must have one polarity or phase, and those below the bath, the opposite polarity or phase, so it is not possible to use three-phase current unless the principle of the furnace is altered. In the case of the Héroult furnace the adoption of three-phase would increase the number of electrodes having a prejudicial effect on the simplicity of the furnace and the ease of access to the bath, and increase the amount of regulating mechanism necessary, thereby increasing the difficulties to be encountered.

The three-phase furnaces are to be preferred to the single-phase from the point of view of capital cost. This is particularly the case when an electric furnace is to be installed in a works where there is already electric-generating plant which is supplying a considerable amount of electric power to rolling mills, live rolls, etc., as well as to the furnaces.

I have already mentioned that arc furnaces, and particularly the Héroult furnace, must necessarily be provided with regulating mechanism, in order to prevent the electric generators which supply current to the furnaces being overloaded. If a furnace which is taking a varying load is supplied by one particular generator which is not connected to any of the other generators, then the regulating mechanism can be of the simplest character. If the furnace is supplied from an existing power house, then an expensive motor generator set with a heavy flywheel is required to protect the power house against overloads. This would cause a great increase in the capital cost, and consequently in the cost of current, as the provision of the electrical machinery for supplying a furnace requiring heavy overloads may very easily cost twice as much as machinery supplying the same power to a furnace which does not require large changes of load.

Naturally, variations in the load cannot be prevented with any type of furnace, but it is important to distinguish between gradual changes of load made intentionally and unintentional sudden changes of load. These intentional changes of load take place with the ideal induction furnace, which usually requires a fairly constant load when the furnace is set to work or emptied, or when more or less energy is required to increase or reduce the temperature. All sudden changes of load are practically impossible with the induction furnace. If the induction furnace which is suitable for an electric circuit of normal voltage and frequency has decided advantages over the arc furnaces from the point of view of the generating plant, it must be remembered that the induction furnace has the greater capital cost. The reason of this is that an electric transformer forms part of the induction furnace, while the necessary transformer for an arc furnace is separate from it.

If the combined capital cost of the arc furnace and transformer be compared with that of the induction furnace, the latter is still the dearer on account of the very special construction of the transformer. The increased capital cost of the induction furnace is insignificant compared with the extra capital cost of the generating plant required for an arc furnace, on account of the great variations of load. It may, therefore, be said generally that the cheapest combined plant is obtained by adopting a three-phase furnace, which can work on a circuit of normal periodicity, and does not take great variations of power. The efficiency of the furnace and the capital cost of the installation greatly affect the working costs.

From the electrical point of view, the induction furnace shows far better results than the arc furnace under all conditions. Tests made on a 3½-ton induction furnace at Völklingen have shown an electrical efficiency of 97 per cent., while 10 per cent. of the total energy is lost in the carbons of an arc furnace alone.

Metallurgical Conditions.

These may be deduced from a detailed description of the Röchling-Rodenhauser furnaces working at the Röchling Iron and Steel Works, at Völklingen. There is not much to be said about the metallurgical conditions of the older electric induction furnaces. It has already been mentioned that these furnaces cannot be used for working with slag on account of the annular shape of the hearth, and so they only come under consideration as substitutes for crucible furnaces, as only quite pure materials can be melted in them. In this case the induction furnaces have the advantage that they allow a larger charge to be melted, thereby effecting a considerable saving in the cost of working.

The Röchling-Rodenhauser furnace can equally well be used as a substitute for the crucible furnace, and it offers the additional advantage that refining can be carried out in it. The refining process is carried on in very similar manner in all suitable electric furnaces. It is well known that during the period of dephosphorisation an oxidising slag is formed from lime and millscale or ore, which is removed as far as possible when dephosphorisation is complete. After this period in the Röchling-Rodenhauser furnace recarburisation takes place, and afterwards desulphurisation, and for this latter process the supposition is that a slag free from iron is formed. A good typical slag for desulphurisation has a well-known white appearance, and falls to a white powder on exposure to the air. If the slag has this property, one can leave the charge as long as one likes without any appreciable change in its composition taking place.

These, therefore, are the advantages of a good electric furnace: On account of the convenient regulation of the temperature attainable, the phosphorus can be removed till only a trace remains; it is especially suitable for the most thorough desulphurisation; and finally, when the refining is complete, the charge can be left in the furnace as long as convenient without its composition being changed.

Two Röchling-Rodenhauser steel furnaces are working at the Röchling Iron and Steel Works in the manner briefly described above, one of which is an 8-ton single-phase furnace, and the other a 2-ton three-phase furnace. Both these furnaces are adapted to the existing electrical supply. The 8-ton furnace, which takes 600 kilowatts, takes its power from a 4,000 to 5,000 5-cycle per second generator which existed previously; while the 2-ton furnace, on account of the steady demand for power which it makes, which is characteristic of the Röchling-Rodenhauser furnace, is supplied from the power circuit of the works, just as a motor might be, and takes 200 to 250 kilowatts at a pressure of 400 volts on a 50-cycle circuit. In both cases the high-tension current is supplied direct to the furnace transformer without any danger to workmen being involved.

The furnaces at Völklingen are supplied with liquid metal from the basic Bessemer converters, which contains about 0.08 per cent. of phosphorus and about 0.1 per cent. of sulphur. The various kinds of high-quality steel are produced from this material.

While the small furnace is chiefly used in the production of high-class tool steel, the larger furnace is producing chiefly structural steel and similar material, of which large quantities are required. The furnaces at Völklingen are entirely emptied after each charge, so that the preceding charge cannot produce any effect. Whilst the furnace is usually supplied entirely with molten metal, sometimes only one-third to

one-half of the charge is taken from the converter and the remainder is melted from small scrap, and in this case the quality of the material obtained is excellent, and the furnace is entirely emptied.

There are two points about the working of the Röchling-Rodenhauser furnace that are worthy of consideration; these are the heating up and the maintenance of the heat of the furnace. In order to heat up induction furnaces before charging, it was usual in the past to place an iron ring, which was either screwed or welded together, in the annular hearth, which was heated up by the action of the electric current until both it and the hearth were red hot. The fluid metal was then charged into the furnace and heated further until a sufficient temperature is attained to carry out the refining process. This method of heating up requires that molten metal should be charged into the furnace, and this must be first melted in a cupola or in crucibles. This auxiliary melting plant can be dispensed with in the modern electro-furnaces, which do not have to be charged with liquid metal.

The above-mentioned ring would be embedded in pieces of scrap, turnings, etc., so that when the electric current is switched on, the ring is first heated and it in its turn heats up the surrounding material, which frits together and itself becomes a conductor conveying additional current, and increasing the heat of the furnace, so that the entire charge is soon fluid, and the refining process can be commenced.

A further advance has been made in the method by which the furnace is kept hot when not working. In such a case only about one-third to a quarter of the normal energy consumption would be required to keep the Röchling-Rodenhauser furnace hot, and at the present time operations can be stopped before the process is completed with only half the charge in the furnace, since when the doors are closed the furnace is air-tight, and only cools very slowly and gradually. The 8-ton furnace at Völklingen has been left for thirty hours without taking any current, and could be heated up again with the normal energy consumption.

Discussion.

Mr. A. Windsor Richards said he thought there was no doubt in the minds of them all that electric steel, at least for purposes employing high-class steel and special alloy steel, in places where the conditions were favourable, and particularly with regard to the generation of cheap power, had come to stay. He thought that electric steel would have to be considerably cheapened before it could compete with the ordinary processes such as the Bessemer and open-hearth. Mr. Rodenhauser gave them particulars of a rail steel which he had produced in his furnace. That was produced by taking bloom metal from a basic-Bessemer converter and passing it through his furnace. The bloom metal contained 0.80 of phosphorus and 0.1 of sulphur which the furnace reduced to 0.023 of phosphorus and 0.044 of sulphur. Doubtless the author was aware that exactly the same steel could be produced from the ordinary basic open-hearth at a very much lower cost.

Mr. J. M. Gledhill said that in their present smelting, they were simply using coal practically direct, and then, on the other hand, they had to take that same coal and insert a large amount of intermediary plant like boilers, engines, and electrical apparatus. Therefore it seemed to him that the problem of electrical smelting competing in cost was a very difficult one. Although it could not be denied that they produced a very good material with the electrical apparatus, they could also do that with the various smelting processes that were now in vogue. He did not wish to run down the electrical process at all, because he thought that there was probably a great future before it; but he thought that there was a lot of competition and a good deal of ground to be gone over before it could compete with the present processes on a large scale.

Mr. O. Frick stated that he did not agree with the author on most of the points, and thought his conclusions were not always right. The author said with regard to the Stassano furnace, that he did not think it was apt to be used for big charges, because of the great losses, and so on. The carbons in the furnace became too long and too brittle. At another point the author said that he thought the Girod hearth furnace was preferable to the Héroult hearth furnace, because the amount of energy was so constant, and the electrical generators were working in a better condition. The author did not say why it was more constant. To his (the speaker's) idea, it was not more constant. In the hearth furnace it was pretty constant; it travelled round underneath the carbon and heated the air or gases more above the bath, and there were hot gases to transmit the heat to the bath and generate it in the hearth. If the furnace was filled they could not avoid the small pieces of iron and steel tumbling down and coming in contact with the carbons. That again caused the variation of load on the generator. In the Héroult furnace the current had to be taken away through waterproof electrodes fixed in the bottom, and the author supposed that in the Héroult he would get some direct heating by the current passing through the steel. Of course, it was quite evident that was not the case. The amount of heat generated in the steel by the passage of the current only amounted to about 10 watts, which was an infinitesimal amount of energy. Of course, the author was perfectly right in saying that the heat in a hearth furnace was generated in the hearth itself. That was the only part which he (the speaker) thought was of any value. He might be allowed to say that at the present time there was in regular use at Essen, one of his own furnaces. Of course, they were experimenting for some time with it, but it had been working since August of last year. It had been so satisfactory to the firm of Krupp that they had taken over his German patents. At another point, the author said that the furnaces had no side doors, and that the peculiar shape of the hearth naturally prevented the removal of slag. In his furnace they worked the slags very conveniently. The top of the furnace had one single cover, and that was made to rotate on a motor, so that by having one opening they could inspect the whole of the ring-shaped bath. Further, if they wanted to skim off the slag, one man would stand on the cover and put down a skimmer and bring forward the slag to the spout where another man could get it out very easily. He thought that after they had dephosphorised it, in order to avoid sending it back into the bath, the safe way was to empty the whole surface in order to get out every bit of slag, and that could be done at a very small expense of power. The author claimed one very important thing for his furnace, which was that the greatest advantage of his system was that he brought down the primary cost of the installation. To his (the speaker's) idea, that was not a very important thing to bring down, because on the Krupp installation they had spent £75,000, and, of that, perhaps, only £4,000 or £5,000 on the dynamo. The difference between that dynamo and the ordinary dynamo might be something like £1,000. That was of no importance, and, really, if they used a single-phase furnace with only one groove, they could reduce, as they would do, the power consumption. Calculating that on the Röchling-Rodenhauser furnace, he found it was sufficient to bring down the loss by

one kilowatt and gain 15 per cent. One kilowatt was a good gain, considering that the furnace had about 25 or 30 per cent. more radiating area than the furnace with only one single ring. An electric furnace should not, as a rule, compete with Bessemer furnaces for smelting down. It was only to be used in order to get the very high temperature which they could get out of it. When worked in combination with the Bessemer furnace, the electrical furnace had certainly come to stay, having regard to the higher classes of material it could be made to produce

Mr. Hiorth said he understood the Röchling-Rodenhauser furnace to consist of two distinctly different parts, one of them being a furnace with a central quoin, and the rectangular part of it with the current nowing through the plates. If they looked at the diagrams exhibited they would see that one part of the furnace would only be able to give an efficiency of 70 per cent. That was the most that could be reached, because that was the distance between the magnesite and the bath, which would be at least 20 inches, and would give a great field for stray flux. The author said that, electrically, the efficiency in a 3½-ton furnace was 97 per cent., and that part of the furnace would be able to give only 70 per cent. He should think that so much energy would be spent in the rings. The whole efficiency would be at 97 per cent., and in the ordinary rings it might be only 70 per cent., and those rings were giving a very great radiating surface. He should think that if the whole surface together was giving 97 per cent., it was robbing the induction part. The author of the paper further stated that that central quoin system could not be made for big charges. He (the speaker) had found out the same thing, and had been working for six months with a 600-kilowatt furnace. He had found out in that way that flat quoins provided the only system of power induction for big charges. He had seen furnaces in operation giving below 50 per cent. of power factor, and should think that after the trials he had made up to 500 kilowatts and with the construction he had illustrated he had got a power factor of 0.84. That was probably never reached by the power induction furnace before. For treating large capacities and refining steel, the power induction furnace was the cheapest and the handiest form.

Professor McWilliam said there was one statement which he thought had not yet been proved, and ought to be received with great caution. He was sure that the author of the paper would be glad to have the matter pointed out. He did not think it was at all proved that there was no possible chemical action taking place in the molten steel bath even in the induction furnace.

Professor Turner said he would like to raise a point in reference to the question raised by Prof. McWilliam, as to the possible purification by means of a current. They had two cases. On the one hand they had the usual case of where a current was suddenly reversed and they could have no electrolytic action, or, if they did have any, it was instantaneously reversed. But in the case where metal was melted and the current was passing in one direction, it was very possible they had there the condition of an electrode. They had the phosphide of iron and the sulphide of iron dissolved in the iron, and, as they passed the current through constantly in one direction, he believed there was a possibility and an indication of an action, the result of which would decompose some of the phosphide and some of the sulphide, and really purify the metal by means of the current. That was only in one special type of furnace. The author referred to the fact that the induction furnace would not give a high temperature. In accordance with his own experience that was in connection with dephosphorisation in the electric furnace. In the induction furnace the temperature was not so high, and therefore, if there was to be a dephosphorisation, the other types of furnace which would give a high temperature would be more suitable.

Mr. F. Moorwood stated that he considered the induction furnace was not, as steelmakers understood it, a furnace which lent itself to handy working. That was, the resistance form of furnace was more in the form of the present Siemens furnace—a furnace which behaved readily and could be handled by the workman, and, apart from the method of working, could be treated on almost exactly the same lines as the Siemens furnace. What he thought was required was that the furnace should pass out of the hands of the electrician into the hands of the steelmaker. The electricians had done their work, and now the steelmaker ought to get hold of it and lick it into shape.

Mr. E. Adamson remarked that the author seemed to cast a slight reflection upon the Héroult furnace by suggesting that the steel made therefrom was not so homogeneous as that made in his furnace. He (the speaker) just wished to say on that point that steel made in the Héroult furnace was perfectly homogeneous. He had had practical experience of that. So far as the analyses given in the paper were concerned, he had before him 60 consecutive charges made from the Héroult furnace. The maximum phosphorus in those 60 charges was 0.016, the maximum sulphur was 0.026. The minimum phosphorus was 0.011, and the minimum sulphur was 0.016. He thought that those analyses showed a much greater purity than the analyses which the author quoted.

Mr. A. Cooper said that the author stated that the furnaces at Völklingen were supplied with liquid metal from the basic-Bessemer converters. It seemed to him that for the purpose of rail making, until they could take metal over from the blast furnaces or the mixer, the electrical furnaces were not going to form very serious competitors with the basic open-hearth furnace. In Middlesbrough it was quite easy to make steel of the same composition as was given in the paper, in the basic open-hearth furnace.

Mr. T. Rowlands said that for some time past he had been associated with the American Electrical Furnace Company, and they had established a plant at Niagara Falls for the demonstration of the induction furnace. Several steel companies in America had visited the plant, and they had carried out the work with raw material. In one case they melted steel containing 1.2 per cent. of carbon, with a consumption of 400 kilowatt-hours per ton. In other cases they had used only 560 kilowatt-hours per ton, and they had successfully melted ferromanganese at 520 kilowatt-hours per ton, and used for manganese steel somewhere as low as 600 kilowatt-hours per ton. Mr. Frick, in his remarks, mentioned that the slag was not very inconvenient to remove, but he (the speaker) was afraid he must rather differ on that point. It was also mentioned that a power factor of 84 was very unusual. Several times they had had that, and they had had continuous running at 80. Their lowest had been 79, and it had run up as far as 82. Therefore, he thought Mr. Moorwood would see that the furnace had got into the hands of steelmakers now, and that they were making use of it.

Mr. Frick pointed out that what he said about the slag referred, of course, to his type of furnace with a whole cover, and not the type of furnace which Mr. Rowlands had been working.

A start has been made with the preliminary work for the erection of Messrs. Baldwin's new works on the Burrows, Swansea.

Prevention of Accidents in Foundries.*

Report of the Committee of the American Foundrymen's Association.

Your Committee herewith presents its final report, embodying the conclusions reached from a careful canvass of the foundry industry, regarding accidents in it, and the means possible to prevent them.

Early in the year a preliminary report was issued,† which gave the total of accidents reported for the period of one year by 1,084 foundries out of the 6,336 of this country, as 5,242. Eleven of these accidents were fatal, and many of the reports in question contained suggestions on the subject which were highly interesting.

A great diversity of opinion exists on the cause of foundry accidents, which is but natural. The remedies suggested are varied from advice to keep a clear head during casting time, to the prompt discharge of any operative who shows the slightest tendency toward a careless disposition. The replies received further demonstrated the fact very clearly that few shop conditions are the same, and that therefore only general suggestions can be given, leaving each foundry to deal separately with the problem of the prevention of accidents. An interesting point observed was that the fewer the employés the proportionally smaller the number of accidents. It would seem that greater attention is given the individual employé by his immediate superior than is the case where the shops are large and the conditions more complicated. This is further reflected in the seeming reluctance of managers of the larger establishments to take up seriously the deeper questions underlying the welfare of their employés, so far as freedom from accidents is concerned. They are, without question, usually too busy to get to that point. On the other hand it may as well be admitted that there is greater need of respect for shop authority, attention on the part of the employés to their own safety and that of others, and discipline and observance of rules that may be prevailing.

Suggestions for the Prevention of Foundry Accidents.

(1) Weekly or monthly close inspection of all chains, slings, hooks, and ladle bows, etc. This by competent persons, properly reporting to the office. A yearly or semi-annual annealing of chains.

(2) Clean tools and an orderly arrangement of all shop appliances. The compelling of all employés to keep everything in its allotted place when not in use.

(3) Well-lighted shops. Especially on dark days and at night to have lights powerful enough to penetrate steam and dust, and yet give no sharp shadows on the floors.

(4) The use wherever practicable of tram-ways to carry molten metal from the cupola to the floors. When this is not possible, loose earth should be provided about the cupola spout, side-tapping being preferable. (This because the greatest number of accidents by burns are said to occur there.)

(5) Requiring carriers of molten metal to wear the proper kind of shoes, to safe-guard their feet. Providing goggles for the grinders, to protect their eyes.

(6) Prompt action in cases of gross carelessness, disobedience, and taking chances by employés.

Injuries to the Feet.

From the classification of bruises and burns contained in the reports, the latter are credited as causing the greatest number of injuries, and some foundries, in writing, went to considerable length on the question of protecting the feet. On this point one concern comments: "The moulders should always wear boots or shoes of the type which will readily shed drops of molten metal, which may spatter in pouring off. We have occasionally found some of our moulders wearing laced shoes, and have always insisted that they should be more careful in this respect." A western firm employing about 500 men, states that "The majority of accidents were burnt feet. About a year ago, we bought some good, strong shoes and made the moulders put them on during the heat, and it reduced the number of burnt feet materially." A New York firm, under the head of "taking chances," reports accidents caused by molten iron getting into shoes having holes or laces, and says that their men were always cautioned by the foreman, and knew their liability to accident but would not protect themselves. Again on this subject a southern concern makes the following suggestion: "You might recommend a leather cuff to buckle tight around a moulder's leg above his shoe tops and under his trousers, to keep spattered iron out of his shoes. These cuffs should spread out at the bottom and extend below the laces. Burnt feet have given us more trouble than anything else."

It appears that this question of burnt feet in foundries has been given a great deal of attention in Germany. One of its societies (as shown by a reprint in THE FOUNDRY TRADE JOURNAL of England)* states that in collecting statistics, 247 question sheets were received, concerning as many cases of burns to the feet. Of these 244 were from melted iron. The metal came in 238 cases from ladles, and nine from crucibles. Forty-three injuries took place at the cupola, 109 in carrying the iron, and 93 in pouring. Of the 247 cases of accident to the feet 17 men wore shoes with elastic sides, 21 wore long boots, nine wore wooden boots, four wore buckled boots, 10 wore wooden slippers, 145 wore laced boots, and 41 wore low shoes. It will be seen from the above, that the shoes with the elastic sides are the least dangerous, and the laced and low shoes the most.

Injuries to the Eyes.

One Ohio firm having over 500 employés, had in one year 140 persons who required the doctor to remove foreign material from the eyes. A Wisconsin firm, in reporting their accidents, say: "The greatest source of injury is damage to the eyes through flying chips. The Company has provided goggles, for the use of the men liable to such injury, but it is impossible to make the men use them." Another firm makes the same complaint, but apart from recommending goggles, suggests the use of heavy cast-iron shields, extending over emery wheels, and bolted to the stands in such a way that sufficient space is left for the operative to grind his castings, and yet to absolutely protect him from flying pieces should a wheel break.

Safety Devices.

As regards safety devices, a prominent New York editor, writes us as follows:—"I have undertaken an inquiry into this subject, based on one of the bulletins of the Census Bureau, and am surprised to find the small number of accidents that could by

* Presented before the American Foundrymen's Association, May, 1909.

† See F.T.J., March, 1909.

* F.T.J., November, 1908.

any possibility have been prevented by the use of safety appliances." In keeping with this, a large Philadelphia concern, noted for its modern appliances, in referring to their foundry accidents, states: "The accidents in our foundry for the period mentioned, were all such trifling burns, bruises, and cuts as are likely to occur in foundry work. No safety appliance of which we have knowledge would have served to prevent any of the accidents." A large steel foundry in Pennsylvania remarks: "In addition to providing safety appliances, guards for dangerous places and keeping all apparatus and appliances in good order, an employer of labour can do much to prevent accidents by his personal efforts in training his superintendents and foremen to watch over the safety of the men under them, to the extent of instructing them in the safe use of their machines and appliances, cautioning them against taking unnecessary personal risks and in a kindly way calling their attention in the matter each time they are seen to do anything endangering their own or some other man's safety." An Ohio firm says: "Within the last year we have done away with all protruding set screws on shafts, collars, and pulleys, except where not practical, in which case the set screws are covered, making an accident impossible from this source. We have also covered tumbling mill gears and pinions with cast-iron guards, although the chances of an accident here are very slight, on account of the gears running out and upwards, or away from each other. However, the guards now make it absolutely impossible to have an accident." A hollow-sunk set screw now required by law in some States, solves the dangerous set screw problem.

The Brown and Sharp Manufacturing Company, of Providence, R.I., report as follows: "We have taken considerable pains in our foundry to reduce the chances of accidents to as low a point as possible. The doors of a core oven are counterweighted, and these counterweights are made to run in tubes, so that, in case of accident, should a weight fall it will not hit an operator. The large ladle is in a pit, which allows us to draw off the iron into a smaller ladle, and turn it into the larger ladle to mix, while the large ladle is resting on a hydraulic elevator, which can be raised or lowered so that as soon as we have finished filling this ladle and have taken it away we close the hole, and avoid the danger of a man's falling into it. We have also a device on the rail track, so that when the switch is thrown to open the rail, allowing connection to be made with some other part of the equipment, the trolley is held in place, and is not allowed to pass off the end of the track. When this trolley again assumes its proper position the check is automatically thrown out of the way. We have, further, covered our band saws in the pattern shop with wooden cases, which serve also the purpose of preventing the saws flying should they break; and an exhaust is attached, so that the dust is drawn up through the hood and away from the workman. Both the saws and planers have placed before them a rubber mat, so that a person operating is not liable to slip, and here again the sawdust and shavings are exhausted through a pipe."

Photographing Accidents and Keeping Records.

A practice followed by the Lackawanna Steel Company, in maintaining a photograph department, is in such keeping with this report, that we comment here on its utility. When this Company has an accident of any consequence they preserve every piece of machinery and every part of any structure exactly as it was when the accident took place. Even the men who stood near by the injured person are put in position, and the scene is then photographed while it is fresh, and every one is able to say distinctly just where he was, and what he was doing at the time of the accident. Such records are sure to be very valuable in case of any litigation. They are also very useful in acquainting interested parties with the conditions under which the accident took place, and thus afford a means of preventing them in the future. All foundries may not find it advantageous to utilise cameras for this purpose, but a complete record of an accident would be found very useful in any foundry, no matter whether an action at law is anticipated or not.

Accident Insurance and Compensation.

In the preliminary report, mention is made of £9,736 having been spent by 190 concerns, out of 1,084 reporting, for accident premiums. This question is receiving a great deal of attention at the present time, and it will be of interest to record here, a few selected views on the subject. An Illinois firm, having 100 employés, says: "We have a shop employés' insurance paying 37s. 6d. per week for sickness or injury. This is governed exclusively by the employés themselves. This has a tendency to keep every one interested in preventing accidents." A firm in the State of Washington, says: "It is the opinion of the writer that all manufacturers, and those employing labour subject to accidents, should be classified, and all pay a certain tax to a State fund, from which all worthy sufferers should receive a stipulated sum. The fund mentioned could be controlled and disbursed by a commissioner. Impositors should be sent to prison. More than 50 per cent. of the damages actually paid now goes to court costs and attorney fees, and those entitled to the benefit get comparatively little."

A long-established large stove and hollow-ware company, of Illinois, says: "It is manifestly unfair that railroads, manufacturers, etc., should be held responsible for accidents to their employés. We consider railroads but common carriers, who are serving the public interests, and manufacturers do likewise. Society in general profits by these, regardless of the fact that persons enter into business for profit. Labour does not work for the love of toil, nor do manufacturers employ labour in the spirit of philanthropy. It is not a matter of sentiment, but a matter of business. In our opinion, if the law says a man's life is worth £2,000, then let each one contribute to reimburse his heirs for that amount, in the case of death, regardless whether the accident was due to carelessness on his part or not. The responsibility should rest on the State, and not on the individual, and the people in general should contribute towards the support of the same. In our opinion, it is as senseless and absurd as if a manufacturer were to be killed in his own plant, and his heirs expect the men employed in that plant to contribute their *pro rata* of the £2,000 which the law now considers is the worth of a man's life. Few firms are able to stand this imposition, but fortunately these matters are carried from one court to another, until the contestants are worn out and a compromise is effected. It is all absurdly unjust: what we advocate is, that the State should reimburse the heirs, regardless of their financial standing, etc. What is fair for the one, should be fair for the other, and let each man contribute his share towards the support of accident insurance."

It would seem that there is need for educating our employés up to seeing the necessity of every one carrying an accident insurance, and that the injured be promptly compensated by established rates of indemnity, the burden being placed where it can be reliably carried with injustice to no one.

THOMAS D. WEST, Chairman.

Cores and Core Making.*

By F. R. Cheney.

In discussing the question of cores whether in regard to the sand, the mixing, or the binders used, shop conditions and output demanded are naturally very important factors. The following remarks are therefore not intended as specific instructions for making any particular cores. As all pig-irons may be called good irons when properly mixed, and used in the right place, so all core binders are good for their respective lines of work, when treated with the proper degree of intelligence. Core binders may be divided into two general classes. First, those oils or binders not easily affected by moisture, such as linseed oil and its adulterations, dry black compounds, resin, etc. Second, starches or binders readily affected by moisture, such as flour, glue, molasses, and combinations of similar materials. The core-binder salesman and demonstrator can always make a good core, at a very attractive ratio of binder to sand, no matter what binder or compound he has, nor what kind of sand he uses. He will make a smooth, firm, strong core with anything from one part of binder to fifteen to ninety parts of sand—and why? Simply because he is a good mixer. If he were in a well-managed core room and had to show a high mixing ratio, perhaps those watching him would wonder that he did not wear the sand out by rubbing it before making it into a core. But no—he knows he only has one part of compound that must come in direct contact with eighty parts of sand to make a satisfactory core, and the way to get it there is to rub and mix it most thoroughly, and not just to shake it through the riddle and let the outer edge of a conical-shaped pile have ten parts of binder to one of sand.

In foundries that are taking off a heat every day it is not quite as necessary to be so particular as to whether the binder is liable to be affected by dampness or not, for the reason that the core does not often remain in contact with the green sand long enough to become soft from the absorption of moisture in the moulds, but where the time of the heats is uncertain and green sand work done, it is much safer to use a binder that is as little affected by dampness as possible. A core made with a binder that is sensitive to moisture may come from the oven in perfect condition, and yet if it remains in a green sand mould for 24 hours be the cause of blow-holes in the casting on account of the dampness absorbed. It is possible for cores made with flour, glue, molasses, or similar material, when left on shelves in a partially open room, during wet weather, to look all right and yet to have absorbed enough moisture from the air to ruin the castings in which they have to be used.

Cores made from linseed oil or a high grade of core oil, having linseed oil as the base, or the dry black compounds having coal-tars as the base, can be handled without very much regard to weather conditions. They may be kept for weeks in an open shed, where the rain and snow can pass over them, without injury and without danger of a blown casting when using them, if they are dried before placing in the mould. The proportion of binder to sand depends on the thoroughness with which the two are mixed together, as well as on the quality of binder, grade of sand, or size of core. If the number of cores used will warrant the installation of a mechanical mixer, material as well as time can be saved. The rubbing of the binder and sand together can be done mechanically with the old-fashioned sand- or mud-mill, and about 25 per cent. of binder saved over the hand method of a riddle and shovel. This for the reason that the heavy iron roll travelling in the pan kneads and mixes the mass thoroughly in a very few minutes, one or two "V" shaped ploughs hung in the pan assisting in keeping the stock stirred up while the roll is pressing it together. The mud-mill will also grind up the old cores. In using again the completely burned cores, it is difficult, if the operation is undertaken by hand, to properly temper the burned sand on account of its apparent imperviousness to water, but with the mud-mill, the burned sand, gang-way sweepings, or other fine refuse, are thrown in, and dry black compound in the ratio of one part of compound to twenty to eighty parts of old sand added, depending on how completely the old cores were burned out, without any new sand or clay wash at all, and in less than five minutes as good a batch of core stock as is needed for most cores is secured. Cores, 5 ft. long by 3 ft. wide, by from 1 in. to 6 in. thick, are being made successfully every day with nothing but old sand and the dry black compound in the ratio of one part binder to thirty parts old core sand and gang-way mash. To accomplish this result, the dry sand is first put in the mill, then one part of binder to thirty parts of the sand, the mill allowed to revolve a few times to mix the sand and binder while dry, then the water is turned in until the mixture is wetter than is used for any other kind of binder, in fact, almost mushy.

In making cores, the core box must be clean to insure a smooth draw. For general work the sand should be thrown into the box by hand with sufficient power to force it into all the corners and angles. The sand should then continue to be put in until enough is there to support the core rods without danger of the rods cutting through the sand when they are firmly pressed down. The more crooked and the rougher the rods, the better they will tie and hold the stock together. After the rods are placed, the box should be filled and heaped up with sand, and then rammed with a large flat rammer hard enough to compress the entire stock into one firm mass. As a precaution against cores coming apart, it is advisable to avoid as far as possible building them up in layers either by ramming evenly every 2 or 3 in., or placing layers of straight core rods simply crossed, or putting in vent material in the shape of coke, sawdust, etc., in layers that are too even.

A core can be properly baked with either a slow or a hot fire, but will not turn out well if the flame comes in contact with the surface of the core, for in that case the binder is disintegrated.

* Read before the American Foundrymen's Association, May, 1909.

THE summer meeting of the Junior Institution of Engineers is to be held in Birmingham from August 14 to 21 next.

The "Best" Core-Making Machine.

This machine is one of a series which has been designed for the making of cores of various shapes and sizes, and it contains some novel and unique features. By a very simple device of loose or swinging links which are attached to the underside of the table at one end and to the combined lever and handle, a direct vertical lift is obtained without any strain. The plunger spindle, which is machined out of $1\frac{1}{2}$ in. solid mild steel bars, is slotted through for a sufficient distance to allow a brass cross bar, which is attached in the same manner to a loose or swinging link at one end, and to another lever and handle, to which is attached a vent wire, to also have a direct vertical lift. The angle at which these levers or handles are set is so designed that whilst both levers are attached to the plunger spindle and vent wire centrally, they are yet in front of the machine, and in a most convenient position for the operator. The plunger spindle is guided by a bored hole in the table-top, and also a similar machined hole in a cross-bar, which acts as a guide and stay for the legs of the machine. The top of the plunger spindle is shouldered down and screwed to receive the discs of different shapes and sizes. These discs set the various core-boxes centrally with the plunger spindle, and the boxes in turn are secured to the table-top by two cramps and thumb-screws, and can be changed from one size or shape to another in less than one minute. On the right-hand side of the machine attached to the underside of the table is a swinging hook, which engages the handle when lifted up and retains it in position until the core is removed. By placing a

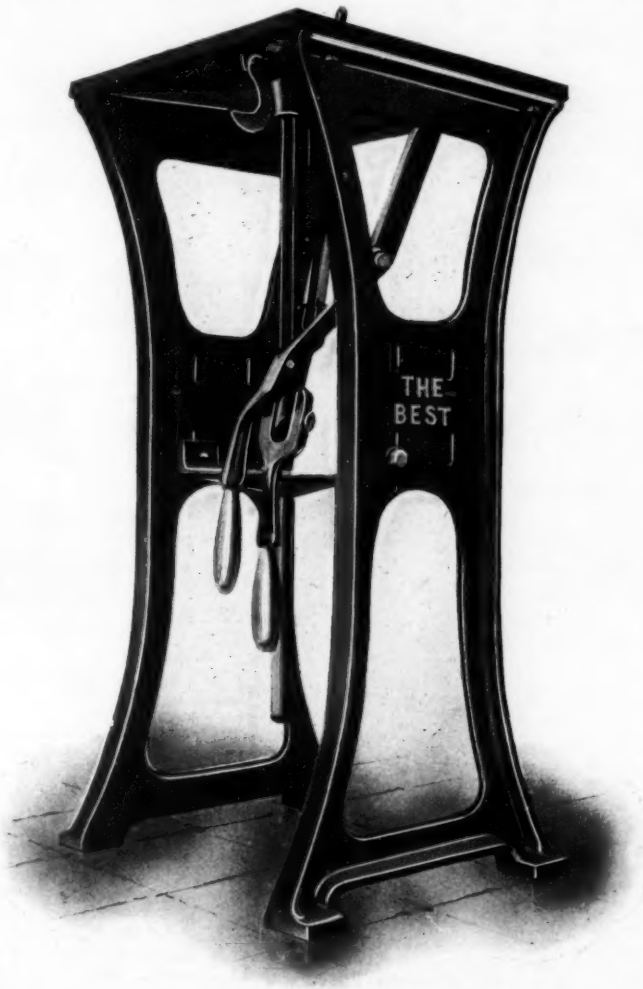


FIG. 1.—THE "BEST" CORE-MAKING MACHINE.

loose brass collar (which is hinged so as to slip over the plunger spindle, and can be screwed up to grip the same) over the crossbar, the lengths of cores can be very conveniently altered to any particular requirement. By a system of slip-in boxes, and boxes with loose bottoms, which can be made by the users, a large variety of intricate cores may be made. This will be seen by the illustration (Fig. 2).

By an ingenious attachment the machine can be fitted so as to make a number of cores at once, so that for large numbers of repetition cores it is quite as effective as for single cores. The cores illustrated were made at the rate (for the most difficult) of 20 per hour, whilst for some of the plain ones on the multiple attachment, 400 per hour have been made, the operator being only a youth

The patentee of this apparatus is Mr. F. Penlington, and the sole agents are Messrs. James Evans & Company, Foundry Engineers, of Blackfriars, Manchester.

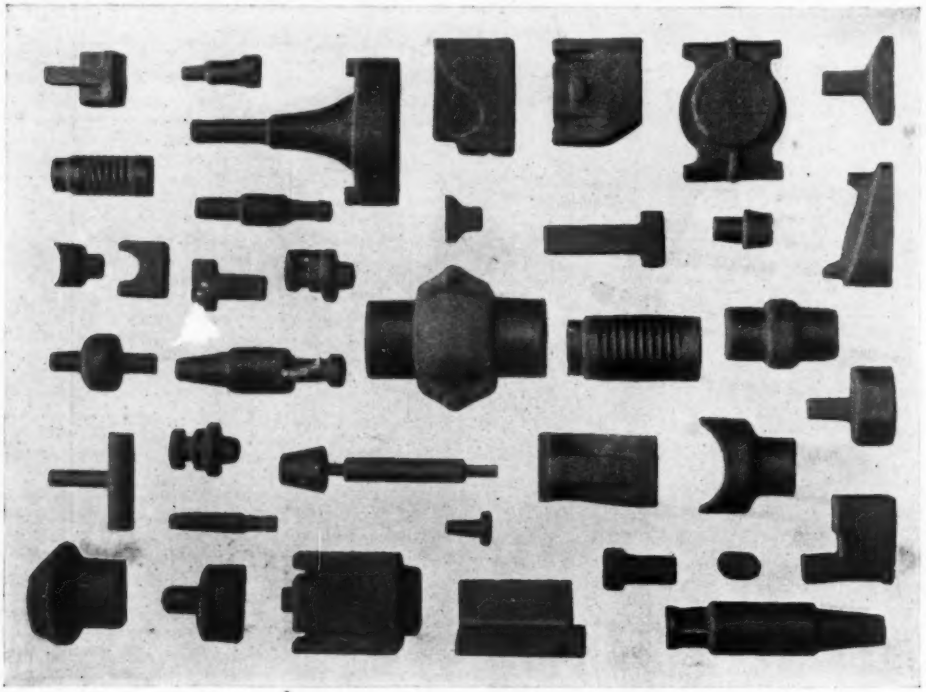


FIG. 2.—EXAMPLES OF CORES MADE ON THE "BEST" MACHINE.

BABBITT METAL.—The original alloy, compounded by John Babbitt, was composed of eight parts antimony, four parts copper, and ninety-six parts of tin. Ordinary soft lining frequently is made up of four parts lead and one part antimony. Old type metal, consisting of two parts lead, one part tin, and one part antimony, is also used for lining. Antimony is easily oxidised, and will burn in the open air if too highly heated, much like zinc. Thus, when either of the alloys described above is frequently heated, the different metals become oxidised, but burn out in different ratios to each other, thereby changing the nature of the alloy to a certain extent each time it is heated. Genuine babbitt will probably change its form more by reheating than the alloys of antimony and lead, but the latter are reduced the most in quantity. The copper and tin oxidise more slowly than the antimony, which quickly burns out, leaving the babbitt much softer than formerly. Lead oxidises much more freely than either copper or tin, therefore the alloy retains more nearly its original composition when a quantity is burned off or oxidised; still the antimony burns out faster than the lead, reducing the hardness of the alloy, but not to the extent it does when mixed with tin and copper. These alloys may be melted, and even kept indefinitely in a molten condition without oxidation, but they must be protected from the atmosphere. A layer of dirt on top of the molten metal will accomplish this, and so will even a layer of oxide or dross; therefore it is advisable not to skim off the oxide as it forms, but let it stay on top of the hot metal. To cover the metal in the ladle or melting pot with pulverised charcoal is also one means of serving the desired end. Carbon largely retards the process of oxidation, and if some salt and soda be added to the coarsely-powdered charcoal, the oxide will, it is claimed, be reduced—that is, the dross will be smelted back into the metal again.

The Practical Value of Chemical Standards for Iron Castings.*

By John Jermain Porter, University of Cincinnati.

The ultimate test of a successful foundry is its ability to make money for its owners, and the three factors which determine its success are: 1st, ability to make good castings; 2nd, the ability to make good castings cheaply; 3rd, ability to sell its product at fair prices. Since the composition of the metal going into the castings has a large influence on both the first and the second of these factors, we may, perhaps, be permitted to consider it in its direct relationship to the commercial success of the foundry.

There are four factors on which the quality of a casting depends: the chemical composition; the treatment which the metal has received in melting; the heat treatment, *i.e.*, casting temperature and rate of cooling; and the perfection of the mould. These four factors are probably of nearly equal importance.

The cost of castings is not so greatly influenced by their composition, and is, perhaps, chiefly governed by the making of the moulds. In certain cases, however, it may play an important part, since the number of wasters or spoiled castings is often closely associated with the composition of the metal and, as all foundrymen know, there is nothing which will send the cost up so rapidly as a large percentage of bad castings. The cost is also influenced by the chemical composition of the metal in another way. That is, by the cost of the iron used. This results from the fact that for any given casting there will be several different compositions, or perhaps a wide range in mixtures, any one of which is equally good. Some one of these, however, will be cheaper than the rest, and hence the foundryman who works according to analysis and with full knowledge of his requirements in the way of composition, can effect a saving in cost which, though small, is not unimportant.

As an example of this, I would mention the case of the ordinary run of machine tool castings which are so commonly made in the foundries of this district (Cincinnati). These castings are of medium thickness, and must be soft enough to machine. Owing to the fact that the foundry is not commonly considered to have any rights that the machine shop is bound to respect, our foundry superintendents have had it most firmly impressed upon them that no crime is so heinous as that of turning out hard castings, and hence the custom has grown up of using from 0.25 to 0.50 per cent. more silicon in these castings than is necessary. In other words, 2.25 per cent. to 2.50 per cent. silicon is very frequently used in work where 2 per cent. is quite sufficient. Now, there is an average difference of 50 cents per grade number in the price per ton of pig-iron (*i.e.*, if No. 2 sells for $14.75, No. 1 will sell for $15.25); also the grade numbers represent a variation of 50 per cent. of silicon, *i.e.*, No. 2 averages 2.25 per cent. and No. 1 2.75 per cent. Thus it may be said that each 0.01 per cent. silicon costs 1 c., and if we use 0.25 per cent. more silicon than is necessary, we unnecessarily increase the cost of our metal just 25 c. per ton. This may seem like a small thing, yet, when we consider that the excessive amount of silicon used has a very injurious effect in the way of producing dirty iron and porous places in the heavy sections, and thus is sometimes accountable for a considerable number of spoiled castings, the point does not seem so trivial.

Another argument in favour of working according to analysis is found in the extensive use of manganese by some of our best informed managers who have learned to appreciate its excellent effects in giving clean, sound iron, and in reducing the scrap pile. One foundryman says that by the use of high manganese pig-iron he is enabled to use large amounts of very cheap high sulphur pig, the manganese counteracting the injurious effects of the sulphur and being itself comparatively inexpensive. This same foundryman also says that he has not had a ton of No. 2 iron on his yard for months, his requirements being obtained by mixing a cheap high-silicon-high-sulphur iron with other cheap low-silicon-high-manganese irons. Of course, with this procedure, very close attention to the details of charging and the methods of receiving the iron in ladles is necessary, but the fact that it can be, and is, done successfully is worthy of careful attention.

An erroneous idea, resulting from lack of confidence in the competency of mixing purely on the basis of chemical composition, is held by some foundrymen. These men will tell you that it is very difficult to make satisfactory castings from northern iron or southern iron alone, but that a mixture of northern and southern brands is necessary for satisfactory results. No doubt this idea had its origin in the days when the grading of pig-iron was done entirely by fracture. Southern pig-iron averages high in silicon, sulphur and phosphorus. Northern iron averages low in these same elements. Hence by a mixture of these two, a happy medium was usually obtained. However, there are some brands of southern iron which are low in phosphorus, and which may be obtained with any desired silicon and sulphur, and by the use of these southern irons of correct composition just as good castings may be made as though a mixture of northern and southern iron giving the same composition were used. The advantage of this knowledge lies in the fact that southern iron can usually be obtained at a somewhat lower price than northern iron for corresponding grade numbers.

As to why our knowledge of foundry metallurgy is not more generally used, I think the explanation will be found in the fact that the various data have not been placed together in such form that the practical foundryman can readily use them. It is well known that within recent years, especially, vast additions have been made to our store of information regarding cast iron, but two facts militate against the use of most of it. The first of these is that but little of this material has been gathered together in handbooks or in such form as to be readily available for use. Most of it, and that the most valuable part, has been published in the various technical journals, and the foundryman who wishes to find the best kind of iron for making hydraulic cylinders, for example, would have to search through the files of perhaps a half-dozen journals,

* Read before the American Foundrymen's Association, May, 1909.

and it might take him two or three days to dig out all the information available on the subject. The other factor is that so much of the material published is written up from the scientific point of view rather than the practical, and hence is not in a form to be understood and applied by the foundryman who has neither the time nor inclination to dig out the meaning of the diagrams, micro-photographs, and long-winded scientific explanations offered. It is true that scientific work is of the highest importance, indirectly, but it needs to be thoroughly digested, correlated with practical experience, and the results restated in ordinary foundry language in order to make it available for practical use. There has also been done an enormous amount of technical experimental work which fails to be of value because of incompleteness; for example, data connecting the strength of iron with varying percentages of silicon are meaningless unless the percentages of other elements are also given. Moreover, statements that an iron of a given composition has such and such a strength is of very little use taken by itself, since the value of a casting is seldom dependent upon strength alone, and there are many other properties of cast iron, such as hardness, shrinkage, density, etc., which must also be considered.

Looking at it from this standpoint, it will be seen that the problem is very complex and not to be approached lightly. Some twenty different physical properties of cast iron may be enumerated which influence its value and adaptability for the manifold purposes for which castings are used. Cast iron may be regarded as an alloy of six elements, *i.e.*, iron carbon, silicon, sulphur, phosphorus, and manganese, and since these elements may be combined in various ways, we may have some twelve or fifteen different constituents. Now, since each separate constituent has, or may have, a specific effect on each of the twenty physical properties, it will be seen that if the problem is to be investigated systematically from start to finish, an almost infinite amount of work will be required. To illustrate: If each of the six elements is varied in only seven proportions, and each resulting metal tested for each of the twenty physical properties, 2,352,980 different experiments will be required. Evidently, then, any such review of the field as outlined here is entirely impossible at the present time. As a matter of fact, such an accumulation of data would, after all, give us only half the information we require, since in a great many, perhaps the majority of cases, the exact physical properties which are necessary to make the best casting of any particular class are not well defined. To take the case of a foundryman making hydraulic cylinders, even supposing that he had all this data at his command, it could not aid him unless he knew also, exactly what degrees of hardness, strength, density, etc., are most desirable in his cylinder.

Evidently, then, the most feasible way of placing this metallurgical data before the foundryman in such form as to make it of practical value, is to first classify castings according to the physical properties which are of importance in them, and then to tabulate the chemical compositions which are found suitable for each class. It would also be highly desirable to take some cognisance of the factor of the cost of the mixture and show, where possible, how the foundryman could cut down the cost of his iron without decreasing the quality of his product. An investigation carried out along these lines, while involving considerable work, would not be impossible, and would certainly be of immediate and direct benefit to the foundry industry. The data needed could be obtained very largely from material already published, and from inquiry among plants making the various lines of castings. Some experimental work would undoubtedly be needed to fill in the gaps, but would probably not be very great in amount. With regard to the classification of castings, Thomas D. West has outlined a system of classification and divided castings into thirty-four classes.* I have not yet looked carefully into this phase of the subject, and am therefore unable to say if this classification would be suitable for our purpose or whether a more or less detailed classification or a classification along different lines would be necessary.

In conclusion, it appears to me highly desirable that this subject be taken up by the American Foundrymen's Association and added to the number of those foundry matters which have been threshed out, systematised and standardised under our auspices. I therefore urge that this meeting take under careful consideration the advisability of appointing a committee for the formulation of chemical standards for iron castings.

* "Suggestions for Procedure in Formulating Standards for General Castings." Trans. Amer. Society Testing Materials 1903.

CALCIUM-SILICON ALLOYS.—A recent patent of Dr. Hans Goldschmidt relates to a process for making an alloy of silicon and calcium free from carbon. Alloys of silicon with barium or strontium may also be made by this method. A mixture of two parts by weight of lime is mixed with one part by weight of silicon and with a suitable flux to produce a slag which crumbles. A convenient flux is fluoride of calcium, which is mixed with chloride of calcium in the proportion of 15 parts of the former to 5 to 10 of the latter, and this mixture is added to 100 parts of the lime and silicon mixture. The mixture is heated in an electric furnace, yielding a calcium-silicon alloy of about 40 parts by weight of calcium and 60 parts by weight of silicon, if practically pure silicon is used. Instead of silicon, ferro-silicon may be used, and instead of lime, carbonate of lime or any salt of calcium which produces lime when being tested. The calcium-silicon alloy thus produced is free from carbon. As the slag crumbles on cooling, instead of forming a solid slag, the light grains of the alloy can be easily separated from the slag by screening.

ELECTRIC SMELTING OF IRON ORE.—In our issue of May we reported that Dr. Haanel had returned to Canada from his investigation of the electric iron-ore smelting furnace of the Aktiebolag Elektrometal, Ludvika, Sweden, of which we published an illustration. While the full accounts of the tests will be contained in the official report to be made by Dr. Haanel to the Canadian Government, Professor Neumann in the course of a recent description, says it is a 1,000-h.p. three-phase furnace with carbon electrodes and with a shaft, similar in design to a blast furnace, the height of the shaft being 18 ft. Here, he remarks, is a possibility of utilising the reducing nature of the carbon monoxide as in the blast furnace; the furnace gases are employed together with other gases. The consumption of coke per 1,000 kg. of pig-iron produced has been reduced to 275 kg., while though the ore and coke contained sulphur (0.55 per cent.), the sulphur content in the pig-iron was very low, 0.005 per cent. The slag contained only 0.35 per cent. of iron.

Standardising Foundry Facings.*

By H. F. Frohman.

To the writer has been assigned the problem of suggesting standards for the more common varieties of foundry facings in use to-day. Almost every foundry, whether producing large or small work, must use sea coal or bituminous facing. This is a ground coal mixed with the sand to prevent it from fusing together and at the same time to peel the casting. This sea coal facing must be high in volatile matter, low in ash and sulphur. It must be what is known as a gas coal, and the most suitable coal for this purpose should show approximately the following analysis :—

	Per cent.
Moisture ...	1.40
Volatile Matter	37.66
Fixed Carbon	54.44
Ash	5.86
Sulphur	0.64

Not only should this coal be high in volatile matter and fixed carbon, and very low in ash and sulphur, but also it must be ground to practically the same consistency as the moulding sand used for the castings. In other words, for heavy work a rather coarse sand is used, and the sea coal used for this purpose should all pass through a No. 14 mesh. For general or medium-sized work, the sand, of course, being finer, a finer ground sea-coal facing would be required, and this should all go through a No. 18 mesh. For small castings such as stove plate and radiator work, naturally requiring a very fine and rather close sand, the sea coal facing should pass through a No. 32 mesh. There is also a sea coal facing which is termed "bolted," which is used for very fine ornamental castings requiring extremely sharp points. As these require also a finely bolted sand in order to make a clean surface and not in any way disturb the face of the mould, it is necessary to have a bolted sea coal facing, which is practically of the same fineness as the moulding sand.

Sea coal facing is used to mix with the sand to peel the castings, in proportions running from 1 part of sea coal facing to 10 to 30 of sand, depending upon the size of the castings; but just in what manner it serves this purpose has not been fully decided upon, nor have our practical foundrymen or chemists given us any sufficiently satisfactory reasons yet why sea coal facing mixed with the sand will peel the casting. In the writer's opinion, sea coal facing mixed with the sand serves not only to prevent the sand from fusing, but also to vent the mould.

In our experiments, we have moulded brake shoes, using the same sands under the same conditions, mixing the sand 20 to 1 with the following :—(1) sea coal; (2) Ceylon plumbago; (3) charcoal; (4) anthracite; (5) sawdust. All of these different materials were ground to the same fineness as sea coal facing. The only good castings produced where the iron did not burn into the sand, were those in the mould made with sea coal facing. The Ceylon plumbago experiment indicated that it was not the separation of the sand particles by a medium preventing fusion that gave the results. Sawdust contains more volatile matter than sea coal, but would not peel the casting. The formation and following deposition of certain hydrocarbons, yielding carbon which peels the casting, may furnish a plausible explanation. This theory does not question or exclude the beneficial effect of sea coal as a venting medium, nor its influence in preventing a fusion of the sand by the separation of sand particles.

Plumbago.

In making castings, especially medium and large size, something is required to face the mould so that it will have practically a smooth surface. The very best article for this purpose is plumbago or graphite with a high percentage of graphitic carbon, the crystalline form from Ceylon giving the best results. A good plumbago or blacking must not only have the proper chemical analysis and be sufficiently refractory to prevent the hot iron from cutting into the mould, but also be of such a nature that it will not retard the flow of the molten metal, but, on the contrary, assist it to glide along.

From experience it has been found that plumbago or graphite of a high graphitic carbon is the most suitable for this purpose, not only in dry sand, but in green sand work, and also for blacking cores.

Ceylon graphite (high grade for facing purposes) should analyse about as follows :—

	Per cent.
Moisture ..	1.20
Oxide of Iron	5.90
Aluminium	3.06
Lime	0.99
Silica	16.14
Graphitic Carbon	72.80

The bulk of Ceylon graphite imported for foundry facings runs between 50 per cent. and 60 per cent. graphitic carbon.

Coke blacking used on certain classes of work should analyse :—

	Per cent.
Fixed Carbon	88.0
Ash	9.0
Sulphur	0.8

Anthracite blacking when used as a pipe blacking or mineral facing should show :—

	Per cent.
Moisture	7.0
Fixed Carbon	84.0
Ash	9.0
Sulphur	0.5

A good grade of charcoal facing which is generally used by the foundries, not only for parting purposes, but also for foundry facing and as a core wash, analyses about as follows :—

	Per cent.
Volatile Matter	10.0
Fixed Carbon	85.8
Ash	3.7

The ash would vary according to the kind of wood and time of cutting.

In judging a foundry facing such as graphite, coke, anthracite, charcoal, the carbon percentage should conform as near as possible to the above.

* Read before the American Foundrymen's Association, May, 1909.

MESSRS. W. PRICE and J. SAUER, manufacturers of flexible shafts and general engineers, Birmingham, trading under the style of the British Flexible Shaft Company, have dissolved partnership.

Some American Moulding Machines.

Moulding machines have become such an established feature in foundry work that no apology is required for presenting particulars of some of those machines which are now being successfully used for increasing the output from the moulding floor. We have from time to time given particulars of various machines that have come under our notice, both those manufactured in this country and abroad, but in the following series of articles we will confine our attention to those American machines which have not been previously described in this journal.

Types of Machines.

There are numerous styles and types of moulding machines, ranging from those which simply compress the sand for the moulder, and have to be operated with almost as much care as is required in the production of a mould entirely by hand, to those machines which do practically the complete moulding operation automatically, including the drawing of the pattern. Of course there is a considerable amount of skill required in the preparation of the pattern plate for certain work, but once this is ready the more highly developed machines will complete the mould, short of placing the cores in position when these are required. Particularly for work of a standard nature is the moulding machine applicable, for where a definite article is continually required the system of machine moulding may be so developed as to almost eliminate skilled labour for the particular work. This is an important feature when regarded from the standpoint of economy, and explains the increasing attention that is being paid to the question by progressive foundrymen. As regards the possibilities of the moulding machine, it is interesting to recall the opinions expressed by the Machinery Committee of the Stove Founders' National Defence Association (America) in their report of September, 1908. Among the conclusions arrived at after a thorough investigation and study of moulding machines in stove foundries, were the following:—"That moulding machines are successfully used in some stove foundries to reduce the moulding cost; that best results are obtained from breaking in an inexperienced operator; that all stove patterns can be moulded with some form of machine or device already in use; that it is merely a question of the cost of patterns for the machine and the number of pieces to be made whether or not it will pay to mould the piece in question by machine; that through the use of these practically indestructible pattern plates in place of loose iron patterns, the cost of maintaining patterns in repair is reduced and the necessity of preserving and caring for duplicate sets of patterns in wood or iron is obviated; that a saving of about 5 per cent. of iron in machine- over hand-moulded castings seems not unreasonable to expect, while an incidental effect on factory economy is suggested by the reduction in the cost of grinding and mounting small cast ranges when the moulds for the castings are produced by machinery."

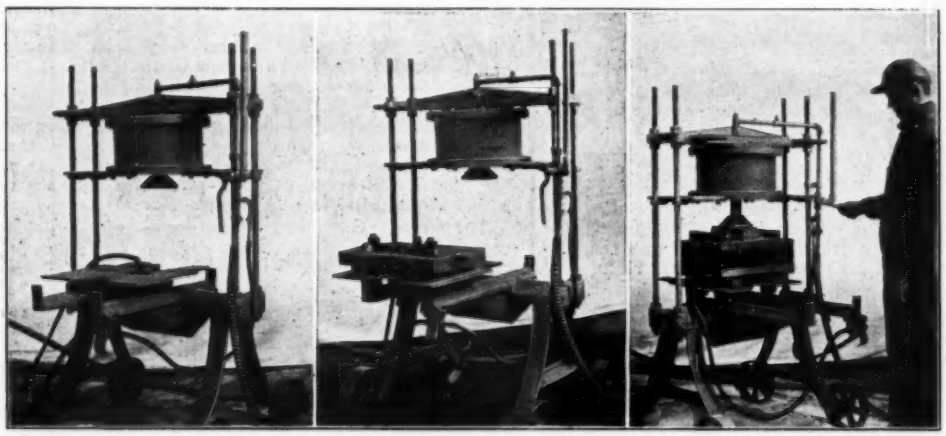


FIG. 1. FIG. 2. FIG. 3.

PORTABLE PNEUMATIC MOULDING MACHINE.

The term moulding machine is applied indiscriminately to a large collection of apparatus, many of which, particularly the hand-operated ones, should rather be classed as squeezers or ramming machines. The more economical mechanism, and that which is properly the moulding machine, combines the operations of moulding, ramming, and releasing or drawing the pattern. The class of work, however, largely governs the style of machine which is most suitable, for where a great number of moulds are to be made to standard sizes the considerations are obviously very different to where only a few are to be turned out. In the latter case the requirements may be such as would not warrant the outlay on an expensive and highly developed machine. This is purely a question for the founder's own judgment, and we do not now propose to deal with it. The following particulars of various machines are presented in order to indicate the variety and descriptions of apparatus available, leaving the question of suitability for special work rather to the individual foundryman requiring to instal machinery. There is one feature, however, that should be common to all machines if they are to prove successful, viz., simplicity of construction, combined with easy access

for cleaning. In a machine which performs automatically a number of operations, there must of necessity be a number of more or less delicately constructed working parts. This, with machinery of a good many classes, would not involve any great trouble in working, but for an apparatus working under foundry conditions, amid the perpetual grit and dirt, this is a matter for grave consideration, and such parts should, where possible be well protected. This will be well understood by any intelligent foundryman, and need not be elaborated on. We propose to make no attempt to classify the machines described, but will present as fully as possible the particulars of such machines as have come under our notice.

A Portable Pneumatic Machine.

A type of portable pneumatic moulding machine suitable for jobbing and also for special foundries is illustrated herewith. This machine is manufactured by the J. F. Webb Manufacturing Company, Davenport, Iowa, U.S.A. The object, when this machine was designed, was to get a portable power machine to do railroad repair work. There were several hand-power portable moulding machines on the market, but no portable power machines. It was also desired to produce a machine that could be used to employ the same patterns as used for hand-moulding, without changing them, and thus save the time and expense of that operation. The apparatus ultimately evolved, as shown herewith, was a power ramming machine, requiring 100 lbs. air pressure, and giving nearly seven tons pressure to the mould. For snap flasks 40 lbs. of air pressure is all that is required.

Fig. 1 shows the machine with the vibrator attached, with knee valve and hose connection. Fig. 2 shows the sand match on the table, ready for the drag part of the flask, and Fig. 3 depicts the drag part of the flask being rammed after being pushed under the cylinder. Fig. 4 shows the drag part of the flask rolled over ready for the cope, after which the mould is pushed under the cylinder and the cope rammed. The next illustration shows the mould lifted off and the patterns drawn ready to set the cores. The cope and drag parts of the flask can be both rammed at one operation when the patterns are mounted on plates or boards, and this operation is shown in Fig. 6.

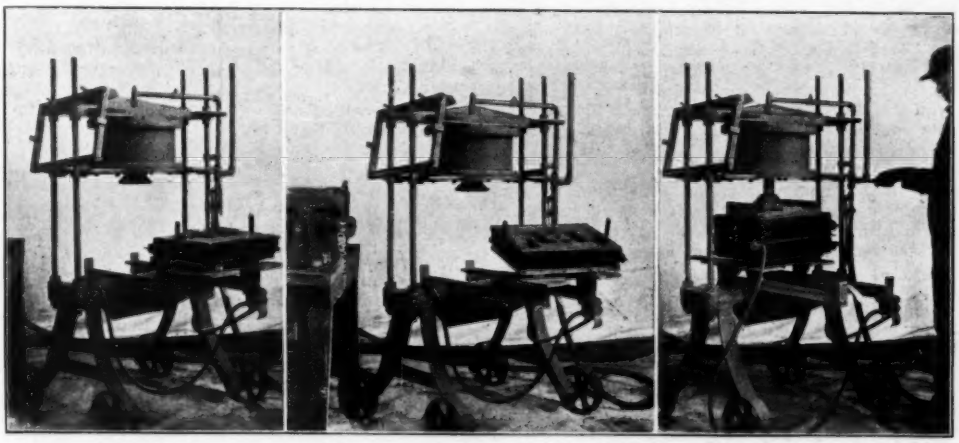


FIG. 4. FIG. 5. FIG. 6.

PORTABLE PNEUMATIC MOULDING MACHINE.

(To be Continued.)

Grinding Dangers.

Home Office Enquiry—*continued.*

The inquiry by the Home Office into the draft regulations for the control of the grinding of metals and the racing of grindstones, the opening of which we recorded in our last issue, was resumed at Birmingham before Mr. A. H. Lush. Mr. S. Pope again appeared for the Home Office, while Mr. G. H. Wright represented the Birmingham Chamber of Commerce and the manufacturers of the Midland district, Mr. H. Hughes the Sheffield Chamber and Sheffield manufacturers, and Messrs. Allan M. Smith and W. G. Davidson the Engineering Employers' Federation and the Shipbuilding Employers' Federation. The inquiry was also attended by Mr. J. A. Redgrave, H.M. Superintending Inspector of Factories.

MR. WRIGHT claimed that all engineering and machine tools should be exempted from Schedule I.

Evidence in reference to steel dust and emery dust was given by MR. ALBERT WHITEHOUSE, managing director of Messrs. Whitehouse Brothers. He said that the dust was heavy, and little floated in the atmosphere, and he had never heard of a workman in their employ dying from grinders' phthisis, or from any other illness caused by the inhalation of the dust created in the work of polishing metals. He did not think it was necessary to employ any

dust-extracting plant in connection with glazing shops. With regard to the racing of grindstones, which was to determine whether the stones were true, Mr. Whitehouse said that to instal exhaust hoods would be too expensive and commercially impracticable. To race on a wet stone would be more objectionable in its effect than that of compelling a workman to inhale a little dust. His firm's grindstones were 7 ft. across, and weighed five or six tons. An exhaust draft appliance had been fixed to emery wheels by order of the Inspector of Factories, but this arrangement had presented difficulties in working. The workmen pooh-poohed the exhaust hoods. There would be no inhalation if respirators were worn.

Mr. Eric H. Piercy, general manager of Messrs. R. Martindale & Company, manufacturers of edged tools, said his firm had no system of exhaust ventilation in the glazing shop, and he did not think it necessary to the operation of glazing metals. His firm had four men who had been with them for over twenty years, and none of them had suffered in consequence of the nature of his employment. There were several objections to wet racing, which would be specially dangerous because of the slime, which would conceal any crack in the stone. If the workman did not notice the defect the crack would probably be opened, and the stone burst, while running, by the action of the water.

Mr. William W. Wynn, director of Messrs. Wynn, Timmins & Company, said his firm spent a considerable sum of money in providing hoods for emery wheels, but the men despised them. He had provided dust-extracting plant in every case where it was necessary, and would strongly object to be required to put in such plant where it was not necessary. All wheels which did not throw dust into the air in such quantities as to be greatly injurious to the health of the workmen should be exempted from the regulations.

Evidence was also given by Mr. George Wilson foreman grinder in the employ of Messrs. Wynn, Timmins & Company, and Mr. Walter White, employed by the same firm, both of whom said they had never suffered illness on account of the nature of their work.

Mr. J. O. Whitehouse, director of Messrs. Cornelius Whitehouse & Sons, Limited, Cannock, tool manufacturers, said he had recently conducted an experiment in wet racing, and had found it unsatisfactory, the man engaged being smothered with water.

On the suggestion of Mr. Hughes, it was agreed, after discussion, that a proviso should be added to the proposed regulation in regard to the racing of grindstones to the effect that work should not be resumed in a room where racing had been carried on until the dust had settled, and had been cleared away.

Mr. Wright submitted that the proposed regulations should not apply to the glazing, polishing, or brightening of edged tools, etc, nor to emery wheels in shops where the grinding done was subsidiary to all other work carried on there, nor to wheels where it was necessary to work on both sides of a spindle. He suggested also that Schedule I. of the regulations should be altered to read: "The manufacture of cutlery, the manufacture of tools, cutting and piercing instruments, and appliances of iron or steel, excluding engineering and machine tools."

Mr. Allan Smith suggested that the regulations ought to apply to factories, and not to processes, and that the following words should be adopted as a proviso in the preamble: "Provided that these regulations shall not apply to the following classes of factories—viz.: Shipbuilding, engine and machine building, machine-tool making, motor-car and cycle manufacture, and general engineering factories and foundries."

Mr. Hughes said he would like particular processes exempted, and after further argument an understanding was arrived at, subject to a form of words to be hereafter adopted. It was agreed that proposed amendments to the regulations should be forwarded to the Commissioners for consideration at a conference to be held in London.

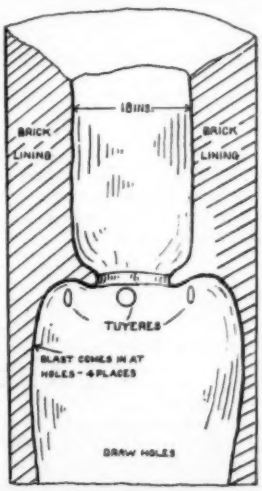
On the question of the practicability of the use of hoods on grinding stones during the glazing of long articles, and the injury to the health of the worker by the inhalation of dust, Mr. Pope called Dr. Colles, medical officer of factories, who stated that dust was created in the grinding rooms, which floated in the air, and was inhaled by the workmen. During the five years ended December the average death-rate from tubercular affections of the lungs in Birmingham was 1,824 per million among the males, against 866 among the females. The metallic dust was most dangerous.

The Commissioner intimated that the inquiry was closed, so far as the public meetings were concerned, and he would endeavour to have a meeting as early as possible in London to settle the form of the regulations.

Queries.

Cupola Troubles.

Will you please tell us what to do with our cupola. We have had it lined to 18 in. diameter, and the metal won't come down as it should. Instead, the lining is working out as shown in the accompanying



sketch, and thick crusts form over the tuyere holes. The wind comes in from the blower at four places and we are using a No. 2 Roots blower driven by a 7-h.p. Crossley gas-engine.

"C. W. R."

Paint for Foundry Roof.

Can you tell us of a dark iron-grey coloured paint suitable for painting the galvanised sheet roof of our foundry?

"F. H."

Inventions.

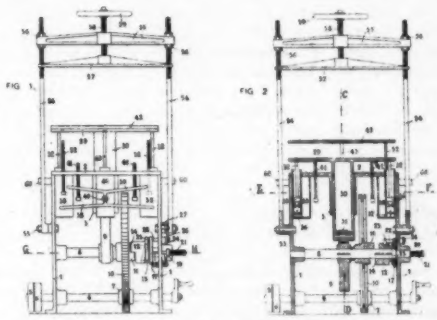
Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

11,080. Furnaces. A. A. Holle.
11,033.*Manufacturing steel ingots and moulds therefor. E. Gathmann.
11,317. Electric furnaces. W. O. Rooper and J B. Belcher, 26, Victoria Street, Westminster.
11,358. Furnace doors. F. Prince, 4, Mitre Court, Temple, London.
11,415. Apparatus for the pressing of moulding sand into moulding boxes. A. Mathieson and Wilsons & Mathieson's, Limited, Sunbridge Chambers, Bradford.
11,423.*Apparatus for casting metals. Broughton Copper Company, Limited, and F. Tomlinson, 17, St. Ann's Square, Manchester.
11,480.*Electric induction furnaces. A. Hiorth and C. W. Söderberg.
11,818.*Doors for furnaces or cupolas. J. Hyslop.
12,018.*Metallurgy in zinc. A. L. J. Queneau.
12,106.*Preparation of iron compounds. J. T. Carrick and B. S. Pattison.
12,432.*Casting metal. T. Critchlow.
12,507. Electrodes for electric furnaces. M. Ruthenburg.
12,710. Heating furnaces, annealing furnaces, etc. W. Kirkham, Wood Street, Sheffield.
12,766.*Charging furnaces. U. Wedge, Clun House, Surrey Street, Strand, London.
12,906.*Furnaces. T. F. F. Lee.
12,927. Revolving muffled calcining and smelting furnace. W. Harries, 4, Southey Street, Roath, Cardiff.
13,262.*Corrugated combustion chamber and corrugated furnace. P. McClen, North Guards, Whitburn, Sunderland.
13,266. Firebars for furnaces. J. W. Claridge, 1A, Gorst Road, New Wandsworth, London.
13,295.*Electric furnaces. H. Nathusius and Westdeutsche Thomasphosphat G.m.b.H.
13,346. Oil furnaces. G. H. Batey, 3, Douglas Street, Wallsend-on-Tyne, Northumberland.
13,408.*Furnace head for gas furnaces with reversible flame. B. Versen, 33, Cannon Street, London.
13,506.*Firing or charging indicators for furnaces. (Electrizitäts Akt.-Ges. vorm, Kolben & Company, Germany.)
13,773. Furnace grates. G. R. Hingelberg and E. Middleton.
13,777. Method of casting ingots. M. Dumuis.
13,858. Founding or casting metals. A. K. Huntington,
13,869. Treatment of iron and steel for prevention of rust. A. E. Tucker, Norwich Union Chambers, Birmingham.
13,923.*Casting articles in metal. S. Barnes.
13,997.*Jointing of pipes, etc. J. G. Stewart, 96, Buchanan Street, Glasgow.
14,141.*Pipe cores and methods of making the same. C. W. McWane, 323, High Holborn, London.
14,245. Open-hearth process for the production of malleable and steel castings. E. C. Angley, 33, Cannon Street, London.
14,246. Crucible process for the manufacture of malleable steel castings. E. C. Angley, 33, Cannon Street, London.
14,351.*Furnaces for the production of cast iron and steel. (Francesco Resinelli, Italy.)

Abstracts of British Patent Specifications recently accepted.

9,346 (1908). *Sand Moulding Machines.* A. Baillot, Haybes-sur-Meuse, and J. Paris, 22, rue d'Athenes, Paris, France.—This invention relates to improvements in machines for making sand moulds of the type in which the parts of a mould are mechanically separated after the impression has been made, and in which fluid pressure is used for drawing the pattern. Fig. 1. represents the machine in elevation with the two plates raised, and Fig. 2 is a vertical section of the machine with the two plates lowered to convenient heights. On the lowered plate 29 a table carrying the pattern is arranged, and a corresponding stripping plate 42 is fitted on the rods 43 of the pistons 44. The pattern is then adjusted in such a manner that it enters with gentle friction into the stripping plate 42, and the table supporting the pattern is conveniently fixed on the plate 29. The stays 54 with the pressure plate 57 are turned into an inclined position, so as to clear the table



Baillot & Paris Sand Moulding Machine.

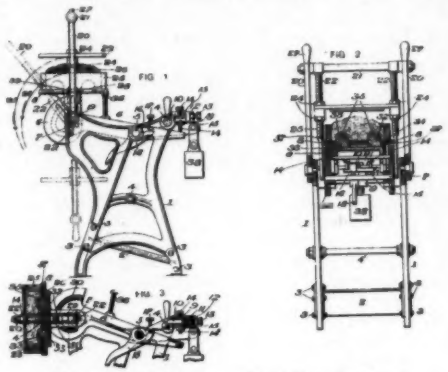
for work. The flask is placed on the stripping plate 42, filled with moulding sand, and the pressure die placed thereon. The rods 54 with the pressure plate 57 are then turned back into the vertical position, and the plate 57 is lowered by means of the hand wheel 59 until it rests on the flask. The mechanical pressure is then applied to obtain the mould.

11,598 (1908). *Decarburisation of Cast Iron.* W. Rübel, Gumpendorferstrasse No. 15, Vienna VI., Austria.—This invention relates to the process of decarburising cast iron by alkaline hydroxides. When treating the iron in a molten condition, the requisite quantity of crude iron is melted in a furnace, and in a retort adjoining it, and consisting of firebrick or steel or iron, the requisite quantity of, say, sodium hydroxide, is melted. When both masses are sufficiently fluid, they are permitted to flow out under ordinary pressure through suitable gates into an outer hearth common to both. The quantities of iron and sodium hydroxide which enter into reaction with one another are determined by the dimensions of the gates. When treating crude iron rich in carbon to about 1 per cent., about one-tenth the quantity of the hydroxide would be used to that of the iron. When the molten iron meets the molten sodium hydroxide, double decomposition takes place, during which the sodium hydroxide is converted into sodium carbonate, thereby decarburising the iron, and liberating the hydrogen and sodium, according to the equation $FeC_2 + 6NaOH = Fe + 2Na_2CO_3 + 2Na + 3H_2$, and the high degree of heat so generated transforms the carbon still remaining in the iron into "perlit." The gases produced in the reaction may pass away to the chimney of the retort and the open air,

or they may be utilised. When treating iron castings, they are immersed in and covered by molten sodium hydroxide in a suitable retort or muffle, whereupon the carbon at the surface of the iron enters into combination with the sodium hydroxide forming sodium carbonate, sodium becoming free. As soon as there is a superficial decarburisation, which takes place at about 750 degrees C., the process almost entirely stops, until the temperature is raised to about 1,050 or from that to about 1,150 degrees C., whereupon, the iron, which is still rich in carbon, under its superficial layer, commences to soften, and carbon travels outward and combines, not with the outer decarburised iron, but with the surrounding sodium hydroxide. The process continues rapidly, and the outer layer of pure iron, which is of increasing thickness and the melting point of which is about 400 degrees C. higher than that of the carboniferous iron, protects the casting against melting and consequently against alteration of shape.

14,093 (1908). *Metallurgical Process for Obtaining Alloys and Steels Containing Silicon.* L. H. Baraduc-Muller, 24, Avenue du Trocadéro, Paris, France.—This invention relates to a metallurgical process for obtaining silicon alloys and steels containing silicon, and consists in forming in contact with the molten metal to be transformed, such as iron, cast-iron, steel, etc., metallic combinations which will have the effect of refining and giving the molten metal the special qualities desired, instead of first producing these transforming metallic combinations and afterwards adding them to the molten metal to be transformed. To this end briquettes are employed, made of mixtures of metallic oxides and siloxycon, etc. The briquettes are generally added to the molten metal when the metallic bath is completely melted or about three-fourths or four-fifths melted, a variable time of from five to twenty minutes being necessary according to the chemical nature of the oxides which enter into mixture with the carborundum in the briquettes, in order that they may become heated and reach the temperature of the furnace, and react. The fusion in a highly liquefied state of the metal coincides as nearly as possible with the end of the reaction of the carborundum on the oxides, and, consequently, coincides with the complete disappearance of the briquettes from the surface of the metal bath upon which they had been placed. Instead of heating and melting apart the mixtures of metallic oxides and amorphous, etc., and afterwards running off the metallic silicides formed, in order to add them subsequently to the metallic bath to be refined or transformed by this addition, the inventor dispenses with these successive steps and performs them all at the same time in a single operation in the furnace which is employed to melt the metal to be refined and transformed. To this end he places upon the surface of the molten metal some of the above-mentioned briquettes compounded with mixtures of metallic oxides and amorphous. As these briquettes have a lower density than that of the metal bath they float upon the surface and become heated by taking heat from the metallic bath, on the one hand, and from the walls of the furnace, on the other hand, and soon reach a temperature of from 1,300 degrees to 1,400 degrees C. in consequence of the perfect calorific conductibility of the compounds of carbon and silicon. At this moment these compounds react on the metallic oxides, yielding silicon alloys or metallic silicides. In proportion as these alloys are produced, the briquettes become smaller, as they are transformed, on the one hand, into carbonic oxide, which is freed and burns in the furnace, and on the other hand, into a metallic compound which has a higher density. The briquettes thus gradually disintegrate and disappear in a relatively short time.

14,944 (1908). *Foundry Moulding Machines.* J. R. Moorhouse, 1836, E. Thayer Street, Philadelphia, U.S.A.—This invention relates to foundry moulding machines of the kind employing a rotatable pattern plate and a rotatable press plate, the moulds being rammed during the rotation of the plates. One of the objects of the invention is to devise a novel construction of moulding machine, in which a greater number of moulds may be made in a given time than in the machines hitherto employed, and in which the combined operations of ramming, rolling over and stripping may be effected at one operation. Fig. 1 represents a side elevation of a machine embodying the invention, showing the flask in position and loaded with sand ready for being rammed; Fig. 2 represents a front elevation of the machine, and part section, showing more clearly the stripping apparatus; Fig. 3 represents a sectional view of a portion of the machine showing the mould rammed and the withdrawal of the pattern about to commence as the operating head is further rotated. 1 designates the side frames, which are secured together by the bridge piece 2 provided with studs 3 and the tie-rods 4. 5 designates a shaft journalled in the frame 1 upon which the operating head or swinging frame 6 is loosely mounted, in which latter a shaft 7

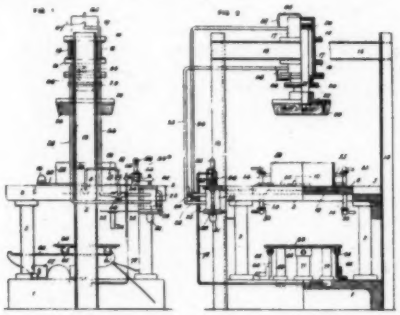


Moorhouse's Foundry Moulding Machine.

is mounted, the shaft 7 having mounted thereon the pattern plate 8. 9 designates a catch plate free to work on shaft 5. Working in this catch plate is the catch 10 operated by spring 11, and secured therein by the gland 12. 13 is a nut attached to catch 10 to prevent the same from protruding too far out of catch plate 9. 14 designates adjustment bolts, and 15 nuts for securing the same to catch plate 9, and is the means of regulating swinging frame 6 carrying the shaft 7 with pattern plate 8. 16 designates knock off cam provided with means of adjustment 17, and is free to work on tie-rod 4. 18 designates the trip lever swinging on shaft 5, operating on catch 10 by the intervening medium of knock off cam 16. 19 designates studs in frame 1, on which are mounted the tension links 20, the ends of which are connected by a tie-rod 21, and extensions of which form handles 27 whereby the operator can pull down the combinations to be further described. Attached to tie-rod 21 are the fork-ended compression links 22. 23 designates the press plate, which is supported and retained in position by the compression links 22. It will be observed that links 22 engage with extensions of shaft 7 in swinging frame 6, the reason being to keep the press plate 23 perfectly parallel to pattern plate 8, since shaft 7 is the centre on which pattern plate 8 is made to rotate. The position of the press plate 23 on compression links 22 is regulated by means of nuts 24 to suit the different sizes of flasks used.

16,379 (1908). *Pneumatic Sand Moulding Machines.* E. Oakes, 46, Ashfield Road, Rusholme, Manchester.—This invention relates to the kind of machines for preparing sand moulds for castings in which the rammer is fixed to the piston rod of a piston, actuated by compressed air in an inverted cylinder, supported above a turn-over pattern plate carrier. Fig. 1 shows a side elevation, and Fig. 2 a partial front elevation and partial section of the machine. On a base plate 1 four pillars 2 are mounted, which support the rectangular open frame or table 3, hereinafter called table. On opposite sides of the table bearings 4 are formed in a central position, in which rest the trunnions 5 of the pattern plate carrier 6, which is likewise a

rectangular open frame. The plate carrier 6 can be turned over on the trunnions, suitable ledges 7 and 8 being arranged on the table 3 and on the plate carrier 6 to hold the latter level with the table, the weight of the vibrator 10 giving a small overbalance on the side which it is on, and the ledges being so arranged that one ledge on the plate carrier 6 rests against the underside of one ledge on the table in one position, and the other ledge on the carrier rests on the top of the other ledge on the table in the other position. The pattern plate 12 is let into the plate carrier 6, preferably flush on both sides, and fixed by screws. The pattern plate is preferably provided with one-half of the pattern to be moulded on each side. To the base plate 1 and the table 3 two uprights 13 and 14 are fixed, which may conveniently be of channel iron, as shown, and to these two cross rails 15 and 16 are fixed, which carry an inverted cylinder 17, formed with suitable flanges 18 and 19, for fixing it to the cross rails. The cylinder is centrally disposed above the pattern plate. The piston 20 of this cylinder is formed preferably solid, with a piston rod 21 of large diameter, to which the rammer head 22 faced with a suitable wood block 23 is fixed. The piston is prevented from turning in any convenient manner, for instance, by a flat side formed on the piston rod and a gland 24 of corresponding shape. At the side of the table 3 a chest 25 is arranged, to which compressed air is admitted from the source of supply through a pipe 26, provided with a stop valve.

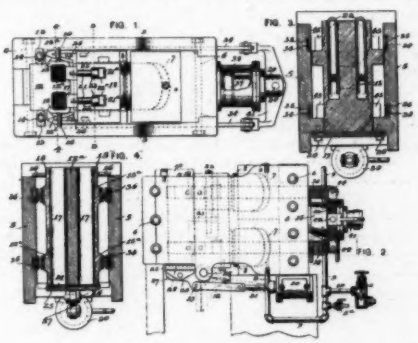


Oakes' Pneumatic Sand-Moulding Machine.

On this chest 25 a valve is arranged, which may be an ordinary D slide valve. On the pattern plate 12 the pattern is fixed or formed as usual, and for moulding the box or flask 52 is placed over the pattern, and fixed on the plate, preferably by inclined swivel catches 53, arranged to turn on studs 54, fixed in the plate carrier 6, which can seize over the lugs 55 on the flask, and after the sand has been rammed in the box, the pattern is loosened in the sand, the plate carrier 6 turned half round, and the box unfastened and drawn off the pattern. For loosening the pattern a cock 57 is arranged on the chest 25, and has a pipe 58 connected to it leading into a bore in one of the trunnions 5 of the plate carrier, a suitable stuffing box 59 being arranged on the trunnion to allow the carrier to be turned.

14,926 (1908). *Refining of Steel in Electric Furnaces.* The Company Bismarckhütte, of Bismarckhütte, near Schwientochlowitz, Upper-Silesia.—In Patent No. 6029 of 1908, there is described a process for refining steel in which the steel previously refined in a basic lined electric furnace is allowed to settle in an acid lined crucible and remains in the crucible as long as necessary, in order to effect settling. Simultaneously with this settling, however, a counter action of the influence of the basic hearth of the electric furnace is effected by the contact with the acid walls of the crucible. This may be still more advantageously carried out if the steel is first subjected to a preliminary refining before introduction to the electric furnace. The applicants have found it much better to first refine the steel in a Bessemer, Thomas or Martin furnace to as great a degree as possible, and then to effect the final refining in the basic electric furnace. In practice, the electric furnace operates just as quickly as the crucible, and there results the combination of first preliminary refining in the Bessemer- Thomas- or Martin- furnace, second the further refining in the basic electric furnace, and lastly the treatment in the crucible. With this combination the refining may be carried out to a much greater extent in the electric furnace, as the steel does not require to be treated so long, and also the action of the crucible, (so far as it consists in the mechanical settling of the slag contained like the ingredients in an emulsion) is to some extent dispensed with so that the crucible plays substantially the part of an acid furnace in causing the steel to take up a small quantity of silicon. In consequence of this, the crucible furnace may eventually be replaced by an acid electric furnace. In consequence of the extremely exhaustive de-oxidation of the metal in the electric furnace, only acid properties are given to the metal in the last stage of the process, that is, during treatment in the acid crucible or acid electric furnace. The physical structure of the metal is therefore favourably affected, and the form of the carbon in solid solution is different from that obtained in Martin-steel as has been proved by analysis of steels melted in electric furnaces, and is similar to that of crucible steel.

23,592 (1908). *Ingot-Casting Machines and Methods of Preventing "Piping" of Ingots.* L. E. Howard, 225, South Ashland Avenue, La Grange, Cook, Illinois, U.S.A.—The machine is adapted to compress the ingots during the period in which they are passing from the molten to the solid state, such compressing operation commencing immediately after the ingots are poured, and being relatively very gently at first but increasing in force as the ingots become denser as cooling proceeds, the pressure being graduated so as to prevent molten steel flowing from the upper to the lower portion of the ingot until the ingot has set. After this has occurred the pressure is further increased, producing an



Howard's Ingot-Casting Machine and Methods of Preventing "Piping" of Ingots.

effect on the steel similar to hydraulic forging, and the pressure is continued until the steel has cooled to a thermal point somewhat below its point of recalescence, and the crystals formed throughout the mass of the steel will not undergo any further change by subsequent cooling. To accomplish these results it is essential that the pressure be applied continuously from the commencement of cooling until the point of recalescence is reached or passed. While the invention is adapted to the production of ingots of all sizes and shapes, it is also adapted to ingots of small sizes, such as are commonly used in the manufacture of tool steel products. Fig. 1 is a top plan view of the improved machine; Fig. 2 is a side elevation of the same; Fig. 3 is a cross-section on the line 3—3 of Fig. 1; and Fig. 4 is a cross-section on the line 4—4 of Fig. 1.

Trade Talk.

BUCK & HICKMAN, LIMITED, have opened new offices, etc., at 55, Station Street, Birmingham, with Mr. Frank Cooper in charge.

R. B. TENNENT, LIMITED, Whifflet Foundry, Coatbridge, are about to start manufacturing heavy iron and steel works plant.

THE CONTRAFLO CONDENSER COMPANY, LIMITED, have opened offices at St. Stephen's House, Victoria Embankment, Westminster, London, S.W.

MR. H. C. JAMES-CARRINGTON has established himself in business at Winchester House, Victoria Square, Birmingham, as a consulting engineer.

M. COCKBURN & COMPANY, LIMITED, Gowan Bank Iron Works, Falkirk, have appointed Mr. L. R. Gronow as their North of England agent.

MESSRS. BROWNING & ONIONS, 65, West Regent Street, Glasgow, have recently been appointed agents for the Weldless Chain Company, of Garteherrie.

MESSRS. E. BUDGEON, W. PARTON, and S. BEER, engineers, etc., Chertsey, Surrey, trading under the style of Herring & Son, have dissolved partnership.

KITSON & COMPANY, LIMITED, of the Airedale Foundry, Hunslet, Leeds, have just secured an order for 22 large locomotives for the Argentine Republic.

MESSRS. N. D. JONES, A. A. PRITCHARD, and C. H. JONES, brassfounders, etc., Birmingham, trading under the style of Jones & Pritchard, have dissolved partnership.

MESSRS. M. METCALFE, and A. Metcalfe, consulting engineers, Sunderland, Durham, who traded under the style of Metcalfe Brothers, notify a dissolution of partnership.

A DISSOLUTION of partnership is notified by Messrs. G. Cooke and W. H. Sellers, electrical engineers, Wilmslow, Cheshire, who traded under the style of George Cooke & Company.

J. HOPKINSON & COMPANY, LIMITED, of the Britannia Works, Huddersfield, have changed their telephone numbers, the new numbers being 1269 and 1270 (two lines) National Telephone Company.

EASTWOOD SWINGLER & COMPANY, LIMITED, Victoria and Railway Iron Works, near Derby, are installing a 10-ton Siemens' melting furnace, which is being supplied and erected by Mr. G. P. Wincott, Saville Street, Sheffield.

A DISSOLUTION is notified in connection with Messrs. J. F. Bradley, G. H. Bradley, and W. E. Jennings, stampers, die sinkers, etc., Birmingham, who traded under the style of Hart & Company, so far as regards Mr. W. E. Jennings.

MR. G. WUTHRICH, Oswaldestre House, Norfolk Street, London, W.C., has appointed Messrs. W. B. & J. Bain, 65, Waterloo Street, Glasgow, as his Scottish agents for the sale of the machinery manufactured by the Maschinenfabrik Oerlikon, Zurich.

CHAMBERLIN & HILL, LIMITED, of Chuckery, Walsall, and the Phœnix Foundry, Lichfield, have acquired certain patterns, etc., from the Atlantic Works, Limited, Wednesbury, and propose shortly starting the manufacture of chilled axle-boxes.

MESSRS. E. H. JOHNSON, A. R. F. M. REINHARDT, A. J. GROSE, R. NIEPEL, and J. M. BEIN, trading under the style of the E.M.F. Manufacturing Company, Ironmonger Lane, London, E.C., engineers' manufacturers, etc., have dissolved partnership.

MR. W. MCNAUGHTAN and MR. R. MEIKLEJOHN, carrying on business under the style of William McNaughtan as engineers and mill wrights at Forth Street, Stirling, have granted a trust deed on behalf of their creditors. Messrs. A. & J. Jenkins, Stirling, are agents for the trustee.

VICKERS, SONS & MAXIM, LIMITED, inform us that in view of the growth of their electrical business, and for the convenience of their customers in London, they have appointed a representative at 28, Victoria Street, S.W. This branch of the business will be under the management of Mr. C. S. Thomson.

THE FERBECK CONSTRUCTION COMPANY have removed their offices from Finsbury Pavement House, E.C., to 66, Victoria Street, Westminster, London, S.W., and the title of the company has been changed to the Ferbeck, Eckardt & Hotop Construction Company. The telegraphic address is "Ferbeckoto, London."

THE firm of R. & J. Fullerton, carrying on business as engineers and shipbuilders' furnishers, at 116, Hope Street, Glasgow, has been dissolved as at January 1 by the retiral of Mr. R. A. Fullerton. The business will be carried on by Mr. J. F. Fullerton, on his own account, under the same firm's name, and he will discharge the liabilities.

MR. J. W. STEWART, Glasgow, the trustee on the sequestrated estates of James Goodwin & Company, engineers and ironfounders, Ardrossan and Motherwell, intimates that an account of his intromissions with the funds of the estate has been audited by the commissioners, who have postponed the declaration of dividends.

MESSRS. PRINCEPS & COMPANY, of the Princeps Works, Sheffield, intimate that owing to their London business having increased so rapidly they have found it necessary to open up a London office at 235, High Holborn, W.C., the telephone number of which is 10449 Central, The company have appointed Mr. R. C. Jennings as their sole London representative.

MR. JOHN MILBURN, engineer and ironfounder. of Workington, is shortly delivering a new blast-furnace hoist he has made for Cammell, Laird & Company, Limited. Other work in hand at Mr. Milburn's works includes a revolving gear for a 15- to 20-ton Bessemer converter and a set of 16-in. direct-driven pumps for the Pallaflat Iron Ore Company, Limited, Bigrigg.

AT an extraordinary general meeting of the shareholders of Muir & Forsyth, Limited, engineers, held at the registered office, 97, St. James' Road, Glasgow, recently, the following special resolutions were duly passed, and at a subsequent extraordinary general meeting confirmed :—"That the company be wound up voluntarily; that Mr. R. Marr Benzie, C.A., Glasgow, be appointed liquidator."

MR. ROBERT DEMPSTER, 44, West George Street, Glasgow, the trustee on the sequestrated estates of George Bell Smith, trading as G. B. Smith & Company, structural engineers, 136, Renfield Street, Glasgow, and Phœnix Works, Govan, intimates that an account of his intromissions has been audited by the commissioners and that a second and final dividend will be paid within his chambers to the creditors on July 17.

AN outbreak of fire occurred recently on the premises of Messrs. James Abernethy & Company, ironfounders, Ferryhill, Aberdeen. The flames were first observed on the ground floor of a two-storey building, the lower portion of which was used as a moulding shop and the upper part as a pattern store. Before the outbreak was extinguished the roof of the building was destroyed as well as the stock of patterns, the estimated damage being put at about £2,000.

DEWHURST'S ENGINEERING COMPANY, LIMITED, Attercliffe Road, Sheffield, are transferring the engineering portion of their business to the Vulcan Works, Tinsley Park Road. These works have recently been erected on land purchased by the company, and have been laid down to meet modern requirements and ensure economic and systematic production. The tract of land acquired by the company will enable them to make considerable extensions, as such become necessary.

IT is stated that a representative of a Midland firm visited Newport recently, and inspected a number of suitable sites for works. We learn that the firm at present exports a considerable quantity of hardware

material from Newport, and considerations of railway carriage have prompted them to seek a site for their works on the seaboard. Their representative was very favourably impressed with the facilities offered for shipment at the Alexandra Docks and Riverside.

With a view to arriving at a satisfactory agreement in regard to the question of the minimum truck load on the North-Eastern Railway, a conference took place recently at the offices of the Board of Trade, in London, between representatives of the railway company and members of the Newcastle and Gateshead Chamber of Commerce. No decision, however, was arrived at. The Chamber of Commerce holds that the minimum of two tons is very injurious to trade on the North-Eastern system, especially as the minimum on other railways is one ton.

In the Edinburgh Court of Session, recently, Lord Guthrie closed the record, and ordered a proof before answer, in an action by the New Lowca Engineering Company, Whitehaven, Cumberland, against the Langloan Iron and Chemical Company, Limited, Coatbridge, for £350, the balance of the price (£1,350) of a pig-iron breaking machine supplied by the plaintiffs to the defendants. The defendants refused to pay this sum, on the ground that the machine was defective, and had to be repaired at a cost of £100, and that delay in delivery caused loss to the defendants, amounting to £323. They claimed to set off these sums in extinction of the balance of the purchase price. Plaintiffs deny the defects and delay.

The International Congress on Mining, Metallurgy, Applied Mechanics, and Practical Geology, which was held during the Liege Exhibition, resolved at its final sitting on July 1, 1905, to accept the invitation of the Rhenish Westphalian mining and steel industry and to hold the next Congress in Rhenish-Westphalia. The Congress will, as a result of this decision, be convened towards the end of June, 1910, at Dusseldorf. The extensive preliminary preparations for this organisation, which is calculated for a week, and which will comprise a discussion of the most important questions in the four sections for mining, metallurgy, applied mechanics, and practical geology, have already been taken in hand. Visits to scientific establishments and industrial works, as well as excursions to geologically interesting districts, serve to supplement the papers and afford a comprehensive insight into the industrial and other conditions of the locality.

The annual meeting of the Machinery Users' Association was held in London, last week. Sir Wm. Holland, M.P., who presided, moved the adoption of the report. He congratulated the members on the success which the Association had achieved in its twenty years' existence. The value of the services rendered by the Association could not be better tested than by its ever-increasing membership. During last year 79 corporations and important companies and firms had joined. The Rating of Machinery Bill had not yet passed into law, but he was glad to say the spirit of the Bill was being acted upon by assessment committees throughout the country, to the advantage not only of manufacturers but of the local authorities themselves. It was to the interest of the authorities to treat owners of machinery fairly, because machinery users, when establishing new factories, would necessarily choose districts where the assessment committees had a reputation for treating machinery users with fairness and consideration. Whenever new works were established the effect would almost certainly be to diminish the volume of unemployment, and thus relieve the burden on the rates. The services which had been rendered to individual firms during the last year in the matter of depreciation of plant had been enormous. One fact could not be too emphatically enforced, namely, that depreciation of plant, extending over several years, could not be recovered. Only one year's depreciation could be recovered. The report was adopted. Sir Wm. Holland was re-elected president, and Sir W. H. Houldsworth and Mr. D. J. Shackleton, M.P., vice-presidents. Mr. Lewis Evans was again elected chairman, and the Council and officers were re-appointed.

Personal.

Mr. Andrew Carnegie has been presented with the honorary freedom of the Borough of Bideford.

We understand that Mr. Alfred M. Wright has been appointed to a seat on the board of the Butterley Company, Limited.

The late Mr. Edward Nettlefold, J.P., a director of Guest, Keen & Nettlefolds, Limited, left estate valued at £124,227 gross.

Mr. C. E. Douglas and Mr. L. C. Grant have been taken into partnership by Messrs. Douglas & Grant, Dunnikier Foundry, Kirkcaldy.

Mr. E. H. Gary, chairman of the United States Steel Corporation, is expected to arrive in France from America towards the end of July.

Mr. R. W. Murray (chairman) and Mr. V. Gordon have been elected permanent governing directors of the Avonside Engine Company, Limited.

The late Mr. I. Dixon, head of Messrs. Dixon & Son, Windsor Iron Works, Liverpool, left estate of the gross value of £40,883, the net personalty being £13,819.

Mr. K. B. Murray has retired from the secretaryship of the London Chamber of Commerce, a position he has held for 27 years, and has been succeeded by Mr. C. E. Musgrave.

The gross value of the estate of the late Mr. Charles Scriven, senior partner in the firm of Messrs. Scriven & Company, engineers, of the Old Foundry, Leeds, is £22,850 5s. 10d., with net personalty £17,932 0s. 9d.

Mr. H. C. Jenkins, the South Yorkshire representative of the British Westinghouse Company, has been elected to the position of managing director of the Mining Engineering Company, Limited, of Foster's Buildings, Sheffield.

Mr. H. Stedall, who recently retired from the positions of hon. treasurer and chairman of the Royal Metal Trades' Pension Society, has been the recipient of a presentation from the Executive Committee, in recognition of his sixteen years' service.

Messrs. J. T. Davies, R. J. Davies, W. H. Davies, and L. Davies, have been taken into partnership by Mr. J. Davies, Highgate Engineering Works, Penbryn, Wrexham, and in future the business will be carried on under the style of Jenkin Davies & Sons.

Mr. A. J. Campbell, who is leaving Barrow to take up the important position of manager of the new shipbuilding yard at Ferrol, Spain, which is being built under the new Spanish naval construction scheme, has been the recipient of a presentation from the workmen engaged at Vickers' Works at Barrow, where he has been works manager.

The Council of the London Chamber of Commerce, at their meeting on the 10th ult., elected Mr. Henry Adams, M.Inst.C.E., F.S.I., etc. (Henry Adams & Son, 60, Queen Victoria Street, E.C.), a member of the Arbitration Committee of the Chamber, in addition to the Engineering Committee, of which he has been a member for some years.

Mr. C. Arthur Head, who has from the incorporation of the company occupied the position of chairman of Head, Wrightson & Company, Limited, has resigned his connection with the board as from April 30, in consequence of his desire to retire from active business. The Hon. W. R. Peel, M.P., has been elected to fill the vacancy caused on the board by the death of Sir Ralph Littler, and the directors also recommend that Mr. J. B. Peat be elected a member of the board.

Colonel T. E. Vickers, in view of his advanced age, has resigned his chairmanship and managing directorship of Vickers, Sons & Maxim, Limited, and the Board has passed a resolution of thanks to him for his services during the past 60 years. Mr. Albert Vickers, who has been a managing director, has been elected chairman. Lieutenant A. Trevor Dawson was appointed a managing director, subject to confirmation at the next ordinary general meeting of the shareholders.

New Companies.

JOHN BRADLEY & COMPANY, LIMITED.—Capital £2,000 in £1 shares (500 preference), to carry on the business of engineers, machinists, founders, etc.

FAIRBANKS, MORSE & COMPANY, LIMITED.—Capital £5,000 in £1 shares, to carry on the business of selling agents and salesmen of oil engines, etc.

J. HARRISON & COMPANY, LIMITED.—Capital £4,000 in £1 shares, to take over the business of engineers carried on at Lowestoft as Harrison & Company.

B. R. WHEATLEY, LIMITED.—Capital £4,000 in £1 shares, to carry on the business of gas, oil, and general engineers, etc. Registered office: Town Street, Armley, Leeds.

HERRING & SON, LIMITED.—Capital £15,000 in £1 shares, to acquire the business carried on at Chertsey as Herring & Son, and to carry on the business of engineers, founders, etc.

ATLAS (CANTON) ENGINEERING COMPANY, LIMITED.—Capital £5,000 in £1 shares, to carry on the business of engineers, boiler-makers, etc. Registered office: 29, Atlas Road, Canton, Cardiff.

EDWARD WILSON & SON, LIMITED.—Capital £7,000 in £1 shares (3,000 preference), to take over the business of engineers carried on at Hawthorn Road, Bootle, Lancashire, as Edward Wilson & Son.

INTERNATIONAL VANADIUM COMPANY, LIMITED.—Capital £40,000 in £1 shares (10,000 deferred), to adopt an agreement with Blackwell's Metallurgical Works, Limited. Registered office: 6-8, Clement's Lane, E.C.

BRIDGWATER CONSTRUCTION COMPANY, LIMITED.—Capital £1,250 in £1 shares, to take over the business of an engineer and ironfounder carried on at 453, Holloway Road, London, N., as the Bridgwater Construction Company.

W. G. ALLEN & SONS, LIMITED.—Capital £12,000 in £1 shares, to take over the business of general engineers and iron and steel workers carried on by G. A. Allen and A. E. Allen, at Prince's End, Tipton, as W. G. Allen & Sons.

B. DANBY & COMPANY, LIMITED.—Capital £5,000 in £1 shares, to take over the business of a wholesale and retail plumbers' merchant or factor, brassfounder, and fitter, etc., carried on by Mr. B. Danby, at Hull, as B. Danby & Company.

DURVITE (1909), LIMITED.—Capital £1,200 in 1,000 ordinary shares of £1 each, and 4,000 "B" shares of 1s. each, to adopt an agreement with C. W. Findley, and to carry on the business of ironfounders, engineers, etc. Registered office: 112A, Queen Victoria Street, E.C.

E. HATTON & COMPANY, LIMITED.—Capital £10,000 in £1 shares, to adopt an agreement with E. Hatton and to carry on the business of ventilating engineers, manufacturers of ventilating machinery and appliances of all kinds, etc. Registered office: 110, Sackville Street, Manchester.

JOHN NORTHWOOD, LIMITED, has been registered with a capital of £2,000 in £1 shares, to acquire the business carried on at 50, Vaughton Street South, Birmingham, as John Northwood, to adopt an agreement with Alma Northwood, and to carry on the business of iron and brassfounders.

MAXWELLS (DUNDEE), LIMITED.—Capital £25,000 in £1 shares (8,000 6 per cent. cumulative preference), to acquire and carry on the business of Maxwell, Son & Company, electrical and mechanical engineers, etc., and brass-founders. Registered office: 26, St. Andrew Street, Edinburgh.

AVONSIDE ENGINE COMPANY, LIMITED.—Capital £50,000 in £1 shares, to acquire the business carried on at the Avonside Engine Works, Fishponds, Bristol, as the Avonside Engine Company, to adopt an agreement with R. W. Murray, and to carry on the business of ironfounders, etc.

FOXCROFT & DUNCAN ENGINEERING COMPANY, LIMITED.—This company has been registered with a capital of £10,000 in £1 shares, to carry on the business of metallurgists, founders, iron, steel, and brass converters, etc. Registered office: Suffolk House, Cannon Street, E.C.

FORWARD & COMPANY, LIMITED.—Capital £1,000 in £1 shares, to adopt an agreement with A. E Parkes and F. O. Wood, and to carry on the business of manufacturers and workers of, agents for, and dealers in engines, boilers, machinery, etc. Registered office: 8, Marsden Court, Manchester.

READS, LIMITED.—Capital £30,000 in £1 shares (5,000 preference), to take over the business carried on as Read Bros., and the Liverpool Press and Tool Company, at Liverpool, and to carry on the business of irondrum and keg makers, engineers, etc. Registered office: 21, Bridgewater Street, Liverpool.

MAX, LIMITED.—Capital £4,070 in £1 shares (4,000 preference), to acquire the business carried on by W. C. Johnson at 152, Westcombe Hill, Westcombe Park, London, to adopt an agreement with L. Burn, and to carry on the business of engineers, etc. Registered office: 152, Westcombe Hill, Westcombe Park, S.E.

GANNOW PULVERISOR COMPANY, LIMITED.—Capital £1,000 in £1 shares, to acquire the licence to use and vend a certain invention of T. Parker for improvements in machines for disintegrating and pulverising materials, and to carry on the business of ironfounders, engineers, etc. Registered office: Black Hill, Entwistle, near Bolton.

COX & COMPANY (ENGINEERS), LIMITED.—Capital £25,000 in £1 shares, to adopt an agreement with H H. Cox, W. R. Cox, E. G. Cox, A. Cox, and W. D. Cox for the acquisition of the business of shipbuilders and repairers, boilermakers, and engineers, etc., carried on at Falmouth as Cox & Company. Registered office: The Docks, Falmouth, Cornwall.

CLARKE'S CRANK AND FORGE COMPANY, LIMITED.—Capital of £20,000 in £1 shares (8,000 preferred, 4,500 Preferred Ordinary, and 7,500 Ordinary), to acquire the business of Clarke's Crank and Forge Company, Limited (incorporated in 1876), and to carry on the business of engineers, etc. Registered office: Coultham Street Crank Works Coultham Street, Lincoln.

SMALL POWER DYNAMO AND MOTOR COMPANY, LIMITED.—Capital £15,000 in £1 shares, to take over the business of electrical and mechanical engineers carried on by J. Bentham, F. S. Blakey, R. Wilson, and J. Bentham at Old Lane, Higher Openshaw, Manchester, as the Small Power Dynamo and Motor Company. Registered office: Old Lane, Higher Openshaw, Manchester.

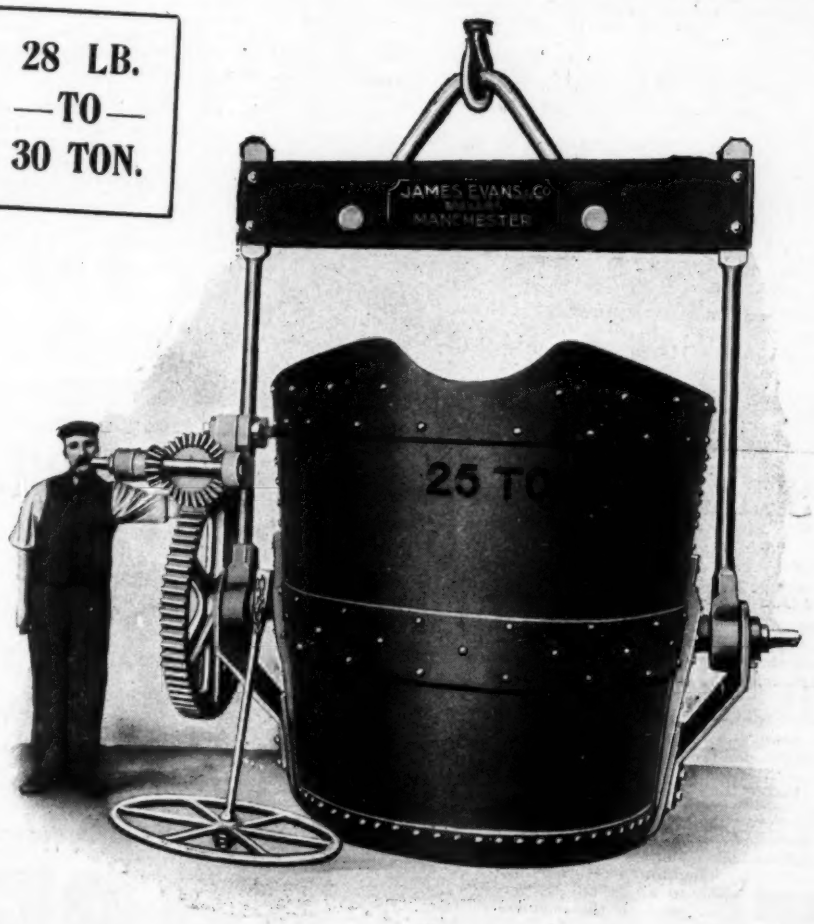
NEW ALLOYS AND PLATING COMPANY, LIMITED.—Capital £3,000 in £1 shares (1,000 10 per cent. cumulative preference), to acquire from the New Alloys Syndicate the benefit of certain existing inventions relating to metal alloys and plating, to adopt agreements with C. M. Ferguson and with the said Syndicate, and to carry on the business of metallurgists. Registered office: 34, Leadenhall Street, E.C.

HARTLEY, CAUSTON & RICHMOND, LIMITED.—Capital £20,000 in £1 shares, to take over the business of constructional engineers, ironfounders, and boilermakers, carried on by J. H. Hartley and H. Causton, at Stoke-on-Trent, as Hartley, Causton & Company, and to adopt agreements (1) with J. W. Hartley and H. Causton (2) with J. W. Hartley (3) with Jacobs Brothers & Richmond, and (4) with W. M. Richmond.

VAUGHAN ENGINEERING INSTALLATIONS, LIMITED.—Capital, £5,000 in £1 shares, to acquire the business carried on at 298-300, Goswell Road, London, as Vaughan & Cook, Limited, together with the underleases of the said premises, to adopt an agreement with W. Brigge, LL.D., and to carry on the business of electric light, gas, hot water and ventilating engineers, etc. Registered office: 298 and 300, Goswell Road, Finsbury, E.C.

FOUNDRY LADLES.

28 LB.
—TO—
30 TON.



JAMES EVANS & CO., BRITANNIA WORKS,

TELEGRAMS—
"LADLES, MANCHESTER."
TELEPHONE—2257.

BLACKFRIARS, MANCHESTER.

Deaths.

THE death occurred at Georgefield, Johnstone, recently, of Mr. Thomas Edward, of Messrs. George Edward & Company, engineers, Johnstone.

MR. T. C. BEELEY, J.P., principal partner of the firm of Messrs. Thos. Beeley & Sons, Hyde Junction Boiler Works, Hyde, died recently aged 40 years.

THE death is announced of Mr. Henry Webb, of Bury, aged 68 years. He was chairman of the firm of Joseph Webb & Sons, Limited, iron and steel manufacturers, Bury.

MR. W. BERTRAM, of James Bertram & Company, Limited, engineers, Leith, died last month, at his residence, 13, Carlton Terrace, Edinburgh, in his fifty-seventh year.

THE death took place recently of Mr. Thomas Smith, of The Grove, Bramley, head of the firm of Messrs. Thomas Smith & Sons, steam and electric crane-makers, of the Old Foundry, Rodley.

MR. A. G. SUTHERLAND, a well-known Birmingham manufacturer, and head of the Sutherland Meter Company, was thrown out of his trap at Erdington, near his house, recently, and killed instantly.

MR. T. D. TINKLER, who was employed at Sir James Laing & Sons' Yard, Sunderland, for 48 years, retiring from the position of outside manager 18 months ago, died at his residence, Stockdale House, Eastfield Street, Sunderland, recently. He was 69 years of age.

MR. D. PARSONS, engineer, of Pensnett, near Dudley, died recently, aged 90 years. At one time the deceased gentleman had control of the Hollies Foundry (Pensnett) and the Albert Foundry (Brockmoor), subsequently becoming financially connected with the Bromley Iron Company.

MR. WALTER LAMONT, principal of the firm of Messrs. Walker, Sons & Company, engineers, Colombo, Ceylon, died suddenly on Helensburgh golf course on the 18th ult. The deceased, who was between 60 and 70 years of age, periodically visited Ceylon, where he retained important interests.

MR. A. OTTEWELL, J.P., died at his residence, Derby Lane, Normanton, Derby, recently. The deceased gentleman, who was in his 49th year, was a brass founder, being managing director of the firm of John Smith & Company (Derby), Limited. He was a member of the Institute of Mechanical Engineers and the Derby Chamber of Commerce.

THE death has occurred of Mr. G. E. Drury, at the age of 59 years. He had been connected with the Trent Iron Works from boyhood, and rose to the managerial position about 1884. When the works was taken over by Messrs. John Brown & Company, Limited, of Sheffield, he was appointed managing director of The Trent Iron Company, Limited.

MR. B. BROWN, J.P., who was well-known in the Widnes ironfounding industry, died recently, aged 73 years. The deceased gentleman took up the management of the Widnes Foundry in 1866, and was taken into partnership 18 years later. He was also a partner of the firm of Messrs. Robinson & Cook, ironfounders, St. Helens.

MR. JAMES SHANKS, general manager of Alexander Shanks & Sons, Limited, engineers, etc., Dens Iron Works, Arbroath, died recently, in his seventy-ninth year. The business was converted into a limited liability company in 1894, under the style of Alexander Shanks & Sons, Limited, the deceased acting as general manager until his death.

MR. G. F. DEACON, a well-known civil engineer, expired suddenly last month in his office at Westminster, London, S.W. Mr. Deacon, who was in his sixty-sixth year, was a member of the council of the Institution of Civil Engineers, and had been president of a number of technical associations. He acted as assistant to Lord Kelvin on the steamship "Great Eastern" in the Atlantic telegraph expedition.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.
J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

The Old English Firm for Superior Quality and Cheapest
STRAW ROPES
PROCTOR BOWES & Co., Newcastle-upon-Tyne.
Write for Prices Immediately.
Telegrams: "PROCTOR BOWES, NEWCASTLE/TYNE." Telephones: NAT. 1683 and 4742 CENTRAL.

PATENT

ALUMINO THERMIC WELDING PROCESS

REG. TRADE MARK.

— FOR —

BROKEN CASTINGS.

REPAIR SHOP

NOW OPEN.

ESTIMATES FOR WORK AND ILLUSTRATED PAMPHLET upon application to

THERMIT LIMITED,

27, Martin's Lane, Cannon Street, E.C.

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From MOUNTFORD PHILLIPS & CO., Llantrissant.

Llantrissant, Octo' er 25th, 1904.

In reference to the Foundry Coke you have been supplying us with for the last six months, we have very great pleasure in letting you know that it has given every satisfaction, and that our Works Manager and Workmen give it the highest praise.

Elders Navigation Collieries, Ltd., Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

METALS.	End June, 1909.	End June, 1908.
Iron—Scotch pig warrants ton	*54/3	*56/3
—Middlesbro' warrants . ton	48 6	51 0
—W.C. M/nos Bessemer ... ton	58 6	60 6
—Stock, Scotch ... .. tons	1,000	1,000
Copper—Chili bars, GMB ton	£59 10 0	£57 12/6
—Stock, Europe and afloat tons	†62,261	37,711
Tin—English ingots ... ton	...£133 5 0	£127 0 0
—Straits ... ... ton	£132 15 0	£125 15 0
—Stock, London, Holland, U.S.A., and afloat ...tons	‡19,818	14,705
Lead—English pig ... ton	£13 10 0	£13 0 0
Spelter—Ord. Silesian ... ton	£21 17 6	£15 17 6
Quicksilver (75lb)... bottle	£8 7 6	£7 17/6–£8 0 0
Antimony—Regulus .. ton	£30 0 0–£31 0 0	£34 0 0

* Settlement price. † June 15th. ‡ May 31st.

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	6 15 0	to	7 0 0
Pipes, 1½ to 2½ in.	5 2 6	to	5 7 6
,, 3 to 4 in.	4 15 0	to	5 5 0
,, 5 to 8 in.	4 12 6	to	4 15 0
,, 10 to 16 in.	4 12 6	to	4 15 0
,, 18 to 24 in.	4 12 6	to	4 15 0
Chairs	3 10 0	to	3 12 6
Floor plates (open sand)	3 0 0	to	3 5 0

SCRAP.

The quotations for scrap, subject to market fluctuations, are as follows: —Heavy wrought (mixed), £2 8s. 0d.; light wrought, £1 1s. 0d.; heavy cast, £2 7s. 0d.; all per ton f.o.b., London. Copper (clean), £53 0s. 0d.; brass (clean), £38 10s. 0d.; lead (usual draft), £12 10s. 0d.; tea lead, £11 0s. 0d.; zinc, £17 5s. 0d.; all per ton delivered merchant's yard.

THE SHEFFIELD SIMPLEX MOTOR WORKS, LIMITED, have put down a gas-fired annealing furnace by Messrs. William Kirkham & Sons. This was put to work some three weeks ago, and has, we are informed by the management, been found a very efficient and economic plant, and although provision has been made for forced draught, in practice natural draught is found sufficient to attain the desired temperature.

THE MIRRLEES WATSON COMPANY, LIMITED, of Glasgow, who were the first to manufacture the Diesel engine in Great Britain, found the demand increase so rapidly that it became necessary to build a large new works to cope with the trade. For financial reasons it was considered preferable that the new works should be controlled by a separate Company, which was formed with works at Hazel Grove, near Stockport. All drawings, patterns, special tools, jigs, etc., were transferred to the new Company (Mirrlees, Bickerton & Day, Limited). The chairman is Mr. A. F. Baird, who is also the chairman of the Mirrlees Watson Company, Limited. The managing director is Mr. Charles Day, who is also managing director of the Mirrlees Watson Company, Limited; and the other director is Mr. Henry N. Bickerton, who is chairman and managing director of the National Gas Engine Company, Limited, of Ashton-under-Lyne.

SILICA FIRE BRICK Co.,

OUGHTIBRIDGE.

GROUND GANISTER,

WET OR DRY.

Silco Cupola Bricks, 90 % Silica.

Better than Fire-clay Bricks for Cupolas.

Established 1863.

JAS. DURRANS & SONS,

PHŒNIX WORKS, PENISTONE, Near Sheffield.

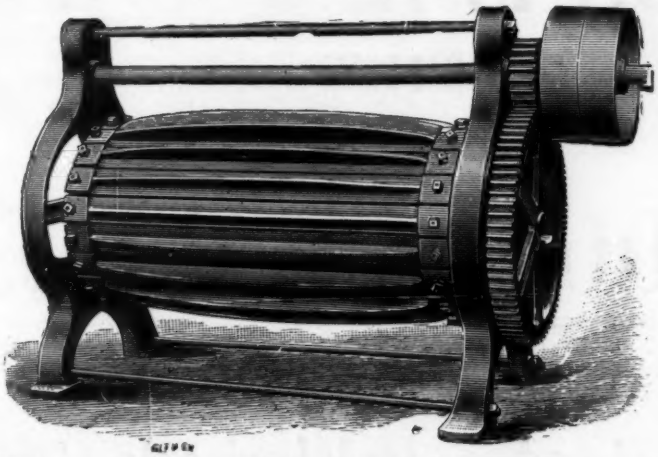
Manufacturers of all

FOUNDRY EQUIPMENTS,

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST.

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

IMPROVED FOUNDRY RATTLER or FETTLING DRUM.



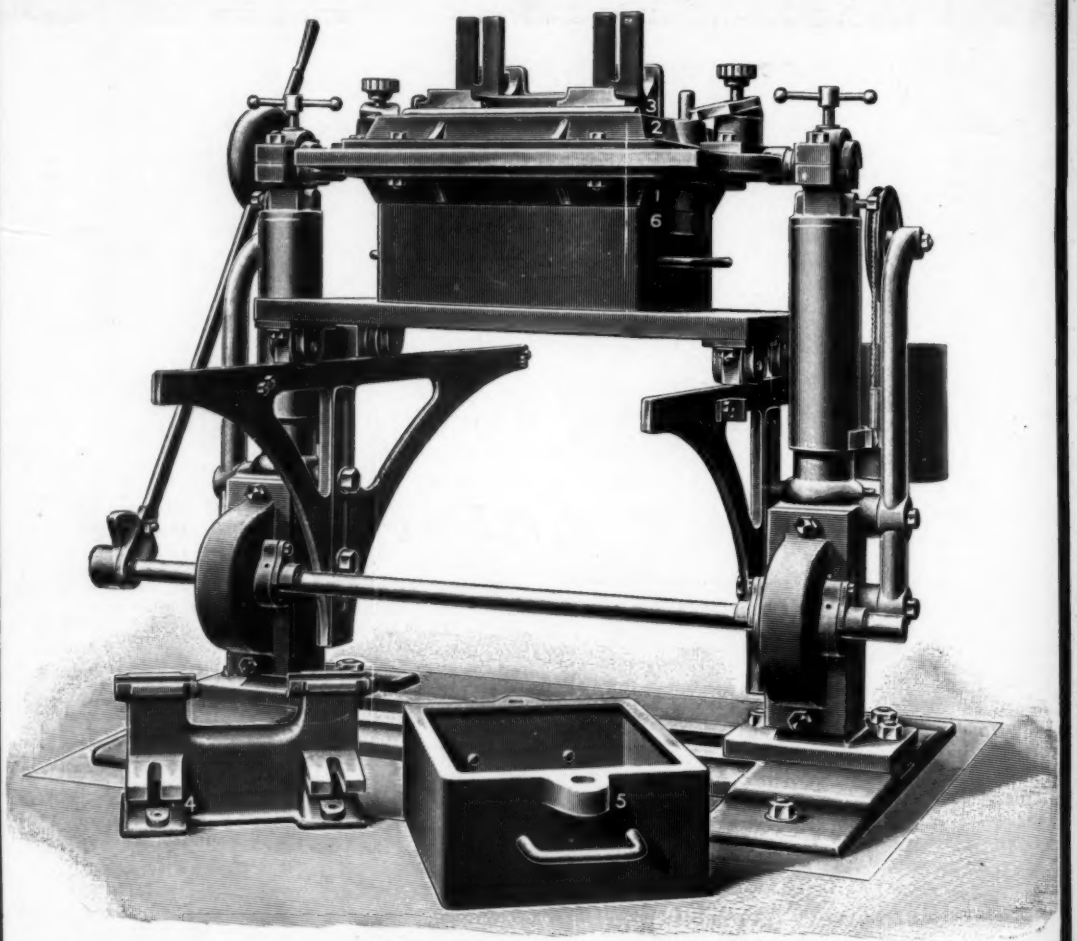
These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD."

HAND RAMMING MOULDING MACHINE.

WITH TURN-OVER PATTERN PLATE.



OUR TURN-OVER MACHINES are better made and turn out more accurate castings than any other Machine on the Market.

MADE IN 44 STANDARD SIZES. QUICK DELIVERIES.

The London Emery Works Co., PARK TOTTENHAM, LONDON, N.

Telegrams: "MAXIUM, LONDON. Telephone: TOTTENHAM 99.

THE BUYER'S GUIDE

Addresses and further information will be found by reference to the Firm's Advertisement.

Abrasive Wheels.
London Emery Works Co.
Jackman, J. W., & Co., Ltd.

Air Compressors.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Electrically Driven).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Steam).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Belt).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Annealing.
Phillips, J. W. & C. J.

Ash Crushing and Washing Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Barrels (Tumbling).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.
Sonnenthal, Selig. & Co.
Tilghman's Patent Sand Blast Co., Ltd.

Barrows.
Durrans, J., & Sons.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.

Bellows.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Durrans, Jas., & Sons.
Jackman, J. W., & Co., Ltd.

Blacklead.
Durrans, J., & Sons.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

Blowers.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Buffalo Forge Co., Ltd.
Davies, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co., Ltd.
Phillips, J. W. & C. J.
Samuelson & Co., Ltd.
Sonnenthal, Selig. & Co.
Thwaites Bros., Ltd.
Ward, T. W., Ltd.

Buffing and Polishing Machines.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Sonnenthal, Selig, & Co.

Casting Cleaners.
Durrans, J., & Sons.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Cement.
Dyson J. & J.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Lowood, J. Grayson, & Co., Ltd.
Marshall & Co., Horace P.
Plasti-Kion Co.
Silent Machine and Eng. Co.

Chaplets and Studs.
Bush, Henry C.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Motherwell, Wm., & Co.
Olsen, Wm.
Wilkinson, T., & Co., Ltd.

Charcoal.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Walker, I. & I.

Charging Platforms.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Thwaites Bros., Ltd.

Coal Dust.
Cumming, Wm., & Co., Ltd.
Durrans, J., & Sons.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

Coke (Foundry).
Elders Navigation Collieries.

Coke Breakers.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W., & C. J.

Core Boxes.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.

Core Compounds.
Bush, H. C.
Cumming, Wm. & Co., Ltd.
Durrans, J. & Sons.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.
Wilkinson, Thos. & Co.

Core Gums.
Durrans, J. & Sons.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

Core Making Machines.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
Jones and Attwood.
London Emery Works Co
Marshall, H. P. & Co.
Phillips, J. W. & C. J.

Core Ovens.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Jackman, J. W. & Co., Ltd.
London Emery Works Co.
Phillips, C. D.
Phillips, J. W. & C. J.

Core Ropes.
Bush, Henry C.
City of London Wood Wool Co.
Durrans, J. & Sons.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Wilkinson, T. & Co.

Core Vents.
Bush, Henry C.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

Cranes.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Jackman, J. W., & Co., Ltd.
Ward, T. W., Ltd.

Crucible Furnaces.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Simplex Coke Oven and Engineering Co., Ltd.

Crucible Furnaces (Lift-out)
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Phillips, J. W. & C. J.

Crucible Furnaces (Tilting)
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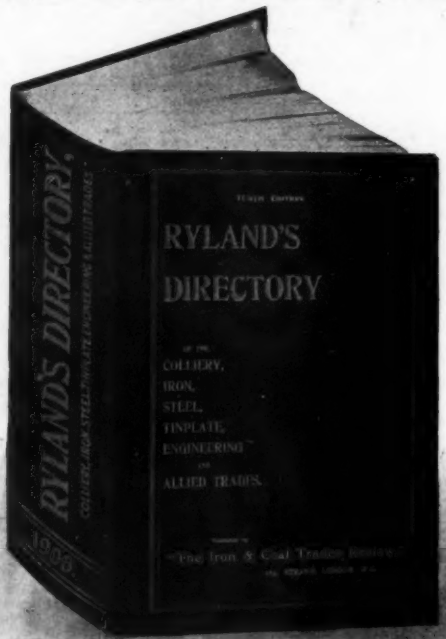

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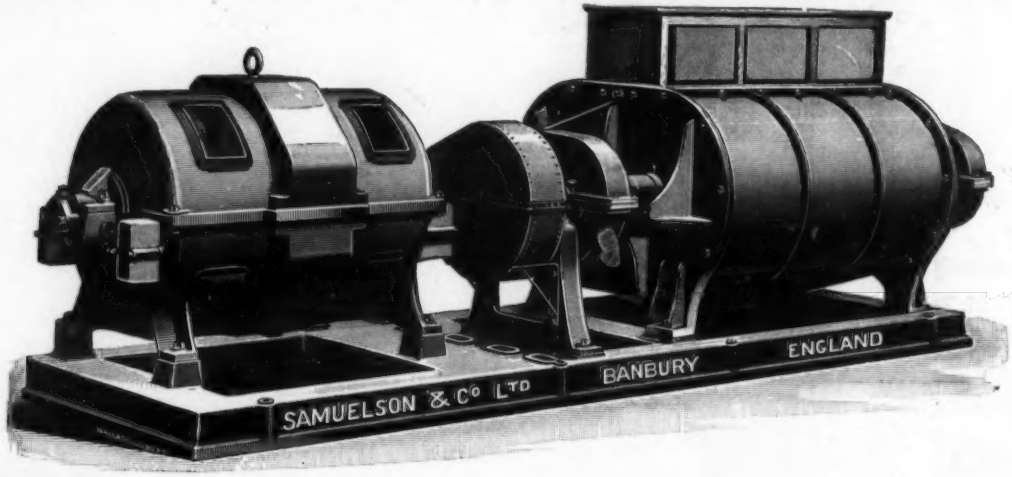

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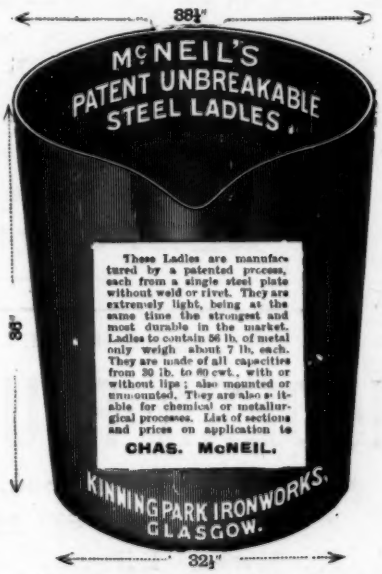
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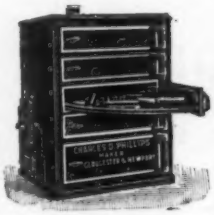

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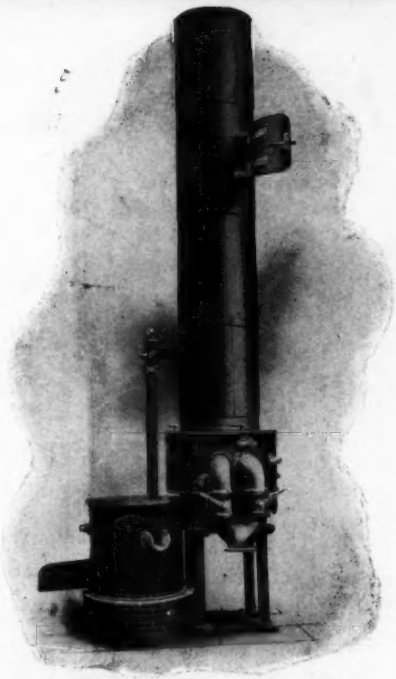

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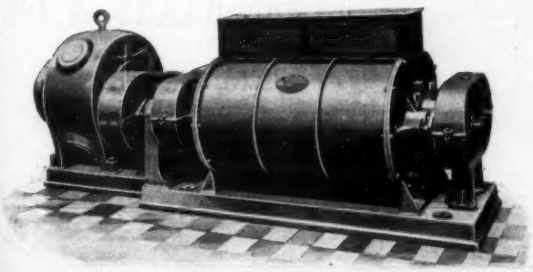

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Forthcoming Event.

AUGUST 3, 4, AND 5.

British Foundrymen's Association.—Annual National Convention at Birmingham.

NOTES AND COMMENTS.

Continuous Melting.

At the recent Convention of American Foundrymen, among the many instructive and interesting papers presented perhaps none excited so much interest and comment as that by Mr. Sleeth. That gentleman, it will be remembered, dealt with "Continuous Melting in the Foundry of the Westinghouse Air Brake Company," and described what might be termed a highly specialised system of the continuous production of standard moulds, and continuous melting and pouring of the metal. There can be no doubt that where a fairly regular product is being turned out this system lends itself to very considerable economies, and much greater attention might well be directed to the question by some of our own foundries. But there is another phase of the question of continuous melting that should be considered even by much smaller foundries than that described by Mr. Sleeth. Continuous melting could be carried out with the ordinary cupola in numerous foundries if a little attention were given to organising the work to such an end; and while in many cases no advantage would be experienced over the practice of pouring the heat at the end of the day, in others far greater flexibility of capacity would result. For instance, instead of the moulding floor being piled up with the moulders' output until the whole could be cast at once, casting would be done at short intervals, as found convenient. This, of course, mainly applies to comparatively small work, for where only large castings of, say, several hundredweights each are being made, the system would present practically no advantages. But with small work the moulding could be done nearer the furnace, less carrying of metal would be involved and the floor space needed for moulding would be considerably reduced. Such a system of continuous melting would involve some adaptation of the ordinary cupola, and radical change in the method of charging, blowing, etc., but these considerations are not such as need deter anyone who conceives possible economies in the system. It would, of course, be necessary to arrange for the tonnage of the moulds to be such at each pouring as to accommodate as near as possible the metal coming down. To any foundry handling a variety of work this could be met by organising the work on the moulding floor, while for a foundry dealing mainly with standard articles and sizes the question would be practically solved already.

Moulds for Casting Aluminium.

While metal moulds have been used with great success the shrinkage of aluminium is too great to allow anything but simple shapes of that metal to be made in such moulds. It is well known, however, that when aluminium is cast in metal moulds, owing to the sudden chilling it becomes much stronger and harder than when cast in green sand. A new form of moulding sand for use in casting aluminium has been invented and patented by Mr. Earl Blough, of

the Aluminium Company of America, of Pittsburg, Pa. (U.S. Patent 915,728, March 23, 1909). The sand is used in exactly the same manner as ordinary moulding sand and, therefore, no change in moulding methods are necessary. The material is a sort of ground carbon mixed with the usual moulding sand. This carbonaceous material may be of various kinds, but the following composition is given by the patentee as being very good:—Petroleum coke 50 parts, electric light carbon 25 parts, and coal-tar pitch 25 parts. The whole is mixed and then baked at a high temperature, after which it is finely ground. This finely ground carbon is then mixed with the moulding sand in the following proportions: Moulding sand, 85 lbs.; ground carbon, 15 lbs. The carbon is ground as fine as necessary for any particular purpose, but for ordinary use a 200-mesh sieve is recommended. The advantage of the carbon in the moulding sand is that it is a good conductor of heat, and thus serves to chill the aluminium. In this manner it acts similarly to a chill mould, but at the same time does not produce a rigid mould, as the sand is moulded in the usual manner. The patentee states that the grain of the aluminium cast in the mould is finer and the metal sounder and stronger. With an alloy containing 92 per cent. of aluminium and 8 per cent. of copper, it is stated that the tensile strength is increased from 15 to 25 per cent. when cast in a mould made in this manner.

Cast-Iron Moulds.

In view of the foregoing, and also in view of the expressed difficulty of accommodating the shrinkage of aluminium in cooling, it is interesting to recall a casting which was shown to us by Dr. Szèkely, the patentee of the Szèkely process of casting in permanent moulds. This casting was by no means a simple one, and weighed something like 60 lbs. It was designed for use as a machine part, and contained numerous recesses and similar intricate parts; but despite this the casting turned out with a beautiful finish, and fitted cleanly into the permanent mould in which it was cast. The shrinkage, we understand, was met by a system of clamping the mould parts together by means of special spring attachments, which allowed a little play when the metal was first poured in, and closed tight on it as it shrunk. How far this system could be applied to other work we are not in a position to say, but the firm for whom this casting was made expressed complete satisfaction with it. The cores used, it may be mentioned, were of a special preparation, the nature of which the inventor would not disclose, but they were sufficiently hard to withstand being sharply struck against iron without suffering damage.

There is no doubt that, apart from those processes which are more or less of a special nature, there is considerable room for improvement in the design and use of permanent moulds for aluminium, as well as for other metals. It is necessary, however, to be prepared to discard entirely the practice and ideas which time has honoured, and which are pursued to-day with veneration, if any great advance is to be made. It may not, of course, be necessary to do so; but many an investigator has stopped short of success on account of undue respect for the things that be. At the same time, we do not stop walking because aerial navigators have managed to attain express train speed through the air; and we will not discard the sand mould because the metal one can be successfully employed for some work.

British Foundrymen's Convention.

We have received from the Secretary of the British Foundrymen's Association the report for the past year, and the programme of the forthcoming Convention at Birmingham, and these we present on another page. The record of the Association's work during the past session is an admirable one, and the success which has attended the efforts to promote the interests of our foundrymen is worthy of unqualified praise. The advance in the membership of the Association is by no means a meagre one, the figure now being 448, consisting of 6 life members, 39 honorary members, 311 members, and 92 branch associate members, as compared with 5 life, 29 honorary, 286 members, 62 branch associate members the previous year. The net gain is thus 66. The quality of the work done in the different branches has also been well maintained, and, in fact, the whole organisation may be said to be steadily advancing.

We should like also to commend the manner in which the report and programme has been placed before the members. These are embodied in a neat hand-book, the programme, which gives not only the titles of the papers, but also a brief synopsis of the same, being interleaved with pages for notes. All desirable information in regard to the various items of the programme is carefully catalogued, and, in short, everything has been done to meet the convenience of the members. If this is a criterion of other efforts put forward in connection with the Convention, it should prove a particularly happy and successful gathering.

Making Phosphor Tin.

For the manufacture of phosphor-tin the following method is recommended in preference to the ordinary method of introducing the phosphorus into the molten tin by means of a phosphoriser. Sponge tin is prepared by melting pure Straits tin and pouring it from a height of several feet into a tub supplied with running water. The sponge tin is then removed and thoroughly dried, or the tin may be prepared in the form of fine shavings. Cakes of yellow cake phosphorus are placed in a saturated solution of copper sulphate for about ten minutes, shortly before they are used, in order to give them a very thin coating of metallic copper so that they may be handled with safety, and they are then dried by rolling in sawdust. The requisite amount of phosphorus (5 per cent. is the usual content for phosphor-tin) is placed in the bottom of a plumbago crucible, covered with the dry, sponge tin, some powdered charcoal added, and the lid of the crucible tightly sealed with a mixture of loam and fireclay. The crucible is heated slowly until the phosphorus has cut the tin and combined with it. The resulting phosphor-tin is then skimmed and poured into suitable moulds, preferably of small size, and set in running water like solder moulds.

English v. American Pattern Shops.

A writer in an American contemporary draws a comparison between the manner of driving machinery in the shops of that country and of England. He remarks that the general method in America appears to be the overhead belt drive, while in England the system largely favoured is that of running all belts and shafting, where possible, under the floor, so that they do not in any way interfere with the worker. The former system requires often a number of belts, in proportion to the number of machines, running from the overhead beams, and as it is quite necessary to have some of the machines in a pattern-shop well away from the wall, some of these belts must occasionally come in the way when long material is being handled. While the worker will in time get accustomed to the presence of these belts, it is much better to have the overhead space as clear as possible;

especially where an overhead crane is installed for handling large patterns. Belts also create a certain amount of draft, which tend to keep in motion the fine dust from the saws, lathes, etc., and there is likewise the danger of breakages with the overhead belts.

It will be readily seen that with the system commonly adopted in England these troubles are to a very large extent avoided. Lathes are generally fixed along one side of the shop. In some instances they are driven direct from the overhead shaft by friction clutches fixed on the main shaft itself, thus avoiding countershaft pulleys, shaft, and belt for each machine. The larger machines, such as saws, band and circular saws, planing and thicknessing machines, combination saws, and similar machines, are belt-driven by a below-floor belt. In the first of two or more bricked trenches a short countershaft is fixed with two pulleys, one to take the belt from the main overhead shaft, the other to drive the next countershaft, whence the various machines are driven by suitable pulleys. The trenches are protected by heavy wooden covers made in parts so as to be easily handled. This system leaves the room quite clear overhead and interferes with very little more floor space than is actually needed by the machines themselves. It altogether obviates the possibility of workmen getting caught by belts, as movable wooden covers are provided to guard the pulleys on the machines and the short lengths of belt that come up through the floor.

We have often been told that we have much to learn from America in the direction of shop equipment and management, but here, at least, that country may with advantage take a tip from us.

Wasters and the Responsibility.

On another page we publish some notes on "Wasters in the Foundry," the author of which touches on the delicate question of the amount of wasters produced by different men. He suggests that the reputations of some foremen for keeping down the production of waste castings would suffer were a visit paid to the foundry and the charging platform before a chance of destroying or disposing of bad castings occurred. There may be a good deal in this suggestion, and in jobbing foundries particularly a remarkably low output of wasters is often recorded—frequently less than in many a highly organised and supervised shop. But, granted that such deception does occur, it is generally the fault of the principal, and results from lax supervision and inconsiderate demands on the foundry foreman. Too often the foundry is owned by a man having very little practical knowledge of the work, who conceives it possible and reasonable to expect that no waste castings should be produced. He does not realise any of the difficulties of the work, and classes any faulty work as the result of sheer carelessness. Consequently the foreman, in order to meet the demands that are placed on him, has recourse to subterfuge, and this is no difficult matter unless a strict system of cost-keeping is in vogue. While it cannot be regarded as just honest to hoodwink one's employer in this way, when a man knows his job depends on his ability to show an abnormally low production of bad castings, it cannot be a matter of great surprise or condemnation if he descends to such a course. The only way to get fair treatment from the foundry is to demand a reasonable output, and to then give the conduct of the work proper supervision.

World's Production of Pig-Iron.

The following statistics, showing in English tons the world's production of pig-iron during the years 1906-8, have been compiled by the Comité des Forges de France:—

	1906. Thousands of Tons.	Per cent. of Total.	1907. Thousands of Tons.	Per cent. of Total.	1908. Thousands of Tons.	Per cent. of Total.
United States	25,308	43.2	25,782	43.0	15,936	33.5
Germany ...	12,281	20.9	12,837	21.4	11,616	24.4
Great Britain	10,149	17.3	9,924	16.6	9,230	19.5
France ...	3,314	5.6	3,531	5.9	3,337	7.0
Russia ...	2,661	4.5	2,775	4.6	2,600	5.4
Austria Hungary	1,688	2.8	1,843	3.0	1 650	3.4
Belgium ...	1,354	2.3	1,384	2.3	1,185	2.5
Canada ...	542	1.0	581	1.0	563	1.1
Sweden ...	596	1.0	606	1.0	554	1.1
Spain ...	373	1.4	373	1.2	373	2.1
Italy ...	135		110		110	
Japan ...	42		43		43	
Other Cntries	200		200		200	
Total ...	58,643	100	59 989	100	47,459	100

It is interesting to note that the world's total production declined in 1908 to below the figure for 1905 (53,700,000 tons), though it was higher than in 1904 and 1903, during which years the output was estimated at 45,050,000 tons and 46,000,000 tons respectively.

Institute of Metals.

The Institute of Metals has just completed the first year of its existence, during which period the membership has increased from barely 200 to well over 500. The first volume of the "Journal" of the Institute is now in the hands of all members, and shortly they will receive notification of the forthcoming autumn meeting. This will take place at Manchester, on Thursday and Friday, October 14 and 15. The arrangements, which are in the hands of a strong local committee, are already well advanced. A series of about half a dozen papers of interest quite equal to those presented at the Birmingham meeting of the Institute, in November last, will be read and discussed at the two morning sessions of the Institute. The afternoon of the first day will be devoted to a visit to the University of Manchester, where members will be officially received on behalf of the University by Vice-Chancellor Alfred Hopkinson, K.C. The new engineering laboratories will be open for inspection, and facilities will also be given for inspecting the Municipal School of Technology. In the evening a reception will be held by the Lord Mayor at the Town Hall. During the afternoon of Friday, October 15, members will have the opportunity of visiting works of metallurgical interest in the neighbourhood of Manchester.

The work of the Institute has increased so considerably that the present offices, which were occupied by the Institute staff for the first time as recently as January last, are already proving to possess insufficient accommodation, and it is, therefore, the intention of the Institute to remove into a more commodious suite of rooms at the earliest possible moment.

We learn that when Sir William White, K.C.B., retires from the Presidency of the Institute at the end of the present year, it is almost certain that Sir Gerard Muntz, Bart., will be nominated to the vacant office. The vacancy in the Vice-Presidency caused by the recent death of Mr. Norman Cookson, of Newcastle-on-Tyne, has been filled by the Council, which, at a recent meeting, unanimously elected Dr. H. C. H. Carpenter, of Manchester.